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DEPARTMENT OF MINES.

MEMOIRS OF THE GEOLOGICAL SURVEY OF NEW SOUTH WALES.

C. S. WILKINSON, F.G.S., &c., GEOLOGICAL SURVEYOR-IN-CHARGE.

PALÆONTOLOGY, No. 4.

R. ETHERIDGE, JNR., PALÆONTOLOGIST.

THE FOSSIL FISHES

OF THE

HAWKESBURY SERIES AT GOSFORD.

BY

ARTHUR SMITH WOODWARD, F.Z.S., F.G.S.,

Of the Department of Geology and Palæontology, British Museum (Natural History Branch), London.

ISSUED BY DIRECTION OF THE HON. SYDNEY SMITH, M.P., MINISTER FOR MINES AND AGRICULTURE.

SYDNEY : CHARLES POTTER, GOVERNMENT PRINTER.

1890.



PRESENTED BY THOMAS WELTON STANFORD

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LETTER OF TRANSMITTAL.

Geological Survey Branch,
Department of Mines,
Sydney, 1 March, 1890.

Sir,

I have the honour to submit Memoir No. 4 of the *Palæontological Series* of the Geological Survey of New South Wales, on the *Fossil Fishes of the Hawkesbury Series at Gosford*, by Mr. Arthur Smith Woodward, F.G.S., of the Geological Department, British Museum.

The collection of fossils therein described contains over four hundred specimens, the examination of which Mr. Woodward generously undertook; and I avail myself of the present opportunity of acknowledging our indebtedness to that able Palæontologist for his valuable work.

The discovery of fossil fish remains in the Hawkesbury Series at Gosford was made by Mr. Blunt, Railway Contractor, when opening a quarry for railway balast; but my attention was first called to their occurrence there by Mr. A. Lambert, who brought me a specimen showing the impression, not only of a fish, but also of a small Labyrinthodont. The latter has been described and figured by Professor W. J. Stephens, M.A., F.G.S., in the *Proceedings of the Linnean Society of New South Wales*, Vol. I (2nd Series).

I sent the Geological Survey Collector to the Gosford Quarry, and he succeeded in obtaining this splendid collection from a small bed of grey shale interstratified with beds of sandstone near the base of the Hawkesbury Series. The latter forms the middle division of the group which comprises, in descending order, the Wianamatta, Hawkesbury, and Narrabeen Series, and is considered to be of Triassic age.

Mr. T. W. E. David, B.A., F.G.S., who has examined the Gosford district, has furnished the accompanying Note on the geological horizon of the Fish-bed.

I have the honour to be,

Sir,

Your obedient servant,

C. S. WILKINSON,

Geological Surveyor-in-Charge.

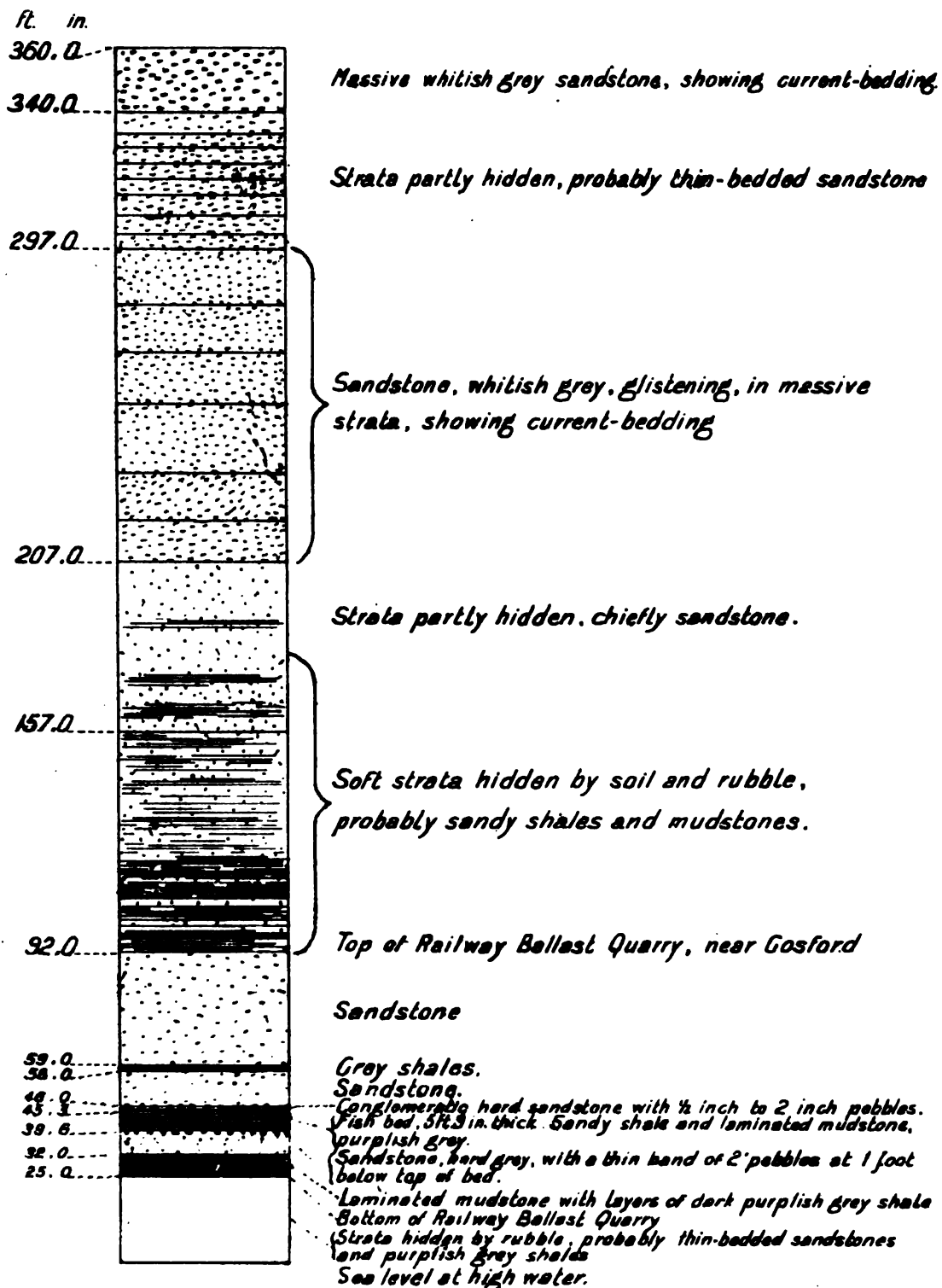
HARRIE WOOD, Esq., J.P.,

Under Secretary for Mines.

SECTION OF HILL NEAR GOSFORD

at the base of which is the Railway Ballast Quarry, from which the remains of fossil fish & labyrinthodonts, described in this memoir, were obtained.

Scale of feet.



STRATIGRAPHICAL NOTE ON THE FISH-BED AT THE RAILWAY BALLAST QUARRY, NEAR GOSFORD.

EVIDENCE for determining the geological horizon of the Fish-bed in the above quarry is afforded by the diamond drill bores at Ourimbah and Wyong to the north, and Mullett Creek and the Jarley Borehole to the south, as well as by natural sections presented by the surrounding hills of Hawkesbury Sandstone.

The natural sections between the outcrops of the Permo-Carboniferous Coal Measures at Coal Cliff on the south, and Lake Macquarie on the north, show that Gosford is situated probably near the middle of the basin, as the strata here are nearly absolutely horizontal, whereas to the north of Gosford they have a general southerly dip, and at a short distance south of Gosford a northerly dip. At the Ourimbah Bore, six miles northerly from Gosford, 1,425 feet of strata were pierced by the diamond drill without the Coal Measures being reached. The greater part of the strata in this bore, between 450 and 1,150 feet, consist of fine shales of a chocolate, red, or green colour. Microscopic examination shows the green shales to be largely composed of tuffaceous material like the cupriferous shales proved in the Holt-Sutherland Bore, and it is probable that much of the chocolate and red shale is composed of altered tuffaceous material, intermixed with the sedimentary. At the Wyong Bore, ten miles northerly from the Ourimbah Bore, the Coal Measures were struck at a depth of $787\frac{1}{2}$ feet, the first 400 feet (approximately) being probably in the same strata which were proved in the lower portion of the Ourimbah Bore. Allowing an increase of about 650 feet of strata between the Ourimbah Bore and Gosford on account of the dip, the approximate thickness of strata intervening here between the Fish-bed and the Coal Measures would be about $650 + 1,425 + 387 = 2,462$ feet (approximately). The Mullet Creek Bore, about ten miles southerly from the Gosford Quarry, was carried to a depth of 1,338 feet without the Coal Measures being reached, the lower 500 feet being chiefly in chocolate and green shales. The depth to the Coal

Measures from the surface of this bore-hole is estimated by Mr. J. Mackenzie, F.G.S., the Examiner of Coal-fields, to be over 2,000 (probably 2,600 feet).* The horizon of the Fish-bed in this bore may be represented by the twenty feet (about) of chocolate shales struck at a depth of 315 feet.

The Jarley Bore at Mangrove Creek, Hawkesbury, penetrated to a depth of 482 ft. $3\frac{1}{4}$ in. without reaching the Coal Measures.† The strata of this bore cannot be correlated with those of the three bores already mentioned. A comparison of the Mullet Creek Bore with the Ourimbah suggests the possibility of the identity of the 450 feet of chocolate, blue, and green shales in the lower part of the former bore with the similar shales struck at 447 feet in the latter, and the 447 feet of sandstone, shale, and fine conglomerate in the latter may be identical with the 409 feet of "grey and brown sandstones and shales with *Phyllothea*," in the former. In this case the depth of the Coal Measures below the Gosford Fish-bed (should the Newcastle Measures underlie this area) would be only about the same as Ourimbah, viz., about 1,800 feet.

The occurrence of such a thickness of sandstone, as proved in the Ourimbah Bore, below the level of the purplish grey shales and flaggy sandstones of the Gosford Fish-bed, renders it doubtful whether the bed belongs to the lower portion of the Hawkesbury Sandstone or to the upper portion of the Narrabeen Shales.

The details of the Section of the Railway Ballast Quarry show that the Fish-bed lies at the top of a group of flaggy hard sandstones, alternating with purplish grey shales with occasional thin bands of clay ironstone. This group, as proved by a neighbouring railway cutting, has a thickness of at least fifty feet. The flaggy sandstones are strongly ripple-marked, and the intercalated shaly beds contain numerous plant remains, too fragmentary, however, for identification. The purplish colour of these shales suggests that they may be composed partly of altered tuffaceous material like the purple shales of Holt-Sutherland and Bulli.

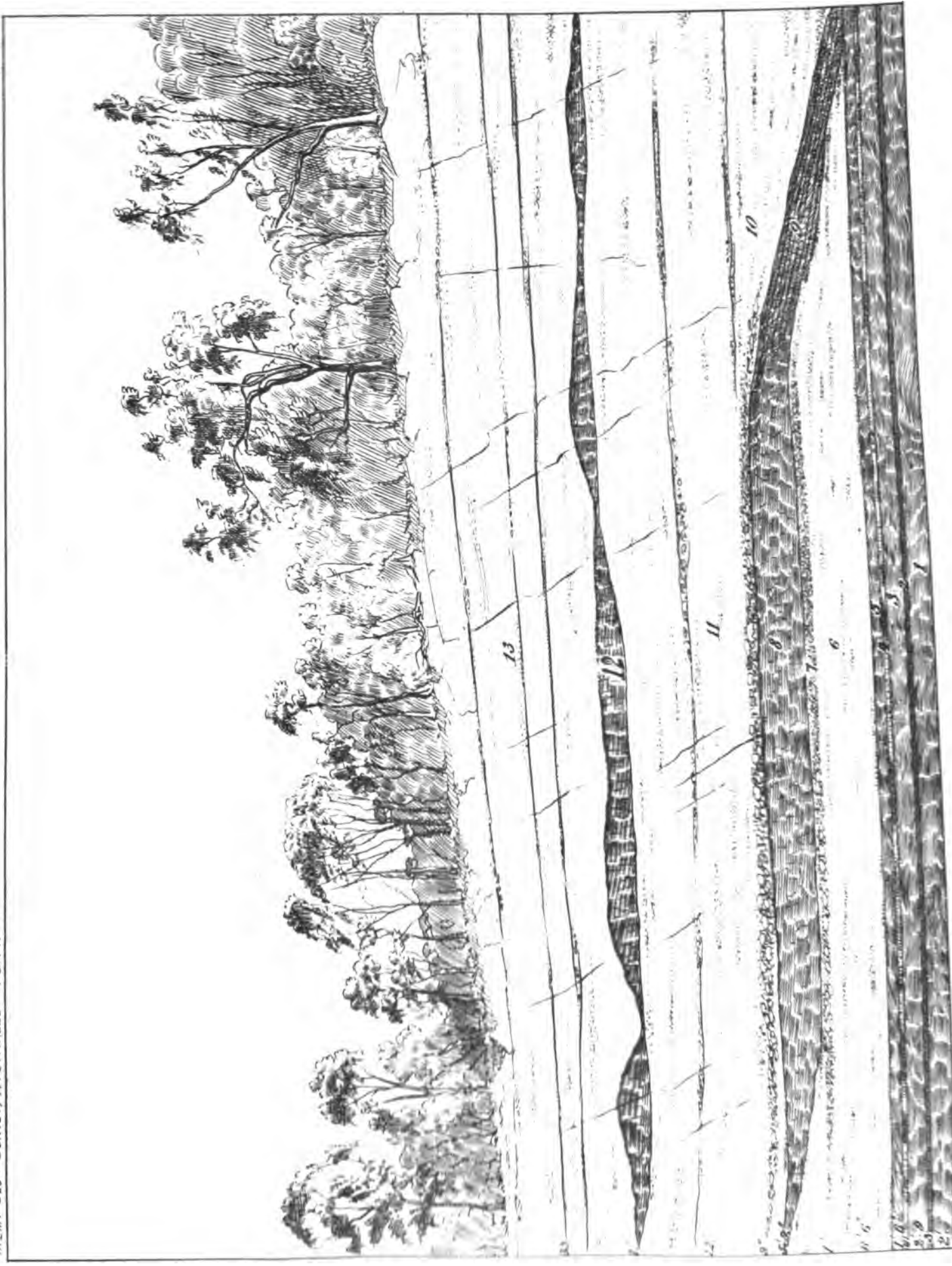
Capping these thin and even-bedded strata is a thickness of about eighty-five feet of massive coarse grey sandstones with patches of gravel, and a lenticular band of coarse pebbles immediately overlying the Fish-bed. The line of junction between the Fish-bed series and the coarse overlying sediments is

* Ann. Report Dept. of Mines, N. S. Wales, second plate, between pp. 208 and 209.

† Ann. Report Dept. of Mines, N. S. Wales, 1878, Plate No. 50.

also marked by slight contemporaneous erosion, as shown to the right of Plate B. Although the shales associated with the Fish-bed are probably partly tuffaceous, it is very improbable, to judge from the remarkable evenness and regularity of these strata, that the fish perished through an inflow of volcanic mud, or the falling of a shower of volcanic dust. The evidence quoted seems rather to favour the supposition that the fish, which evidently lived in some land-locked lake or sheltered estuary, where there was not sufficient current to efface the ripple marks, and where delicate plants could be preserved in the fine muds, were killed by the sudden silting up of the lake or estuary with thick beds of coarse sand and gravel swept down by powerful floods of fresh water.

T. W. EDGEWORTH DAVID.



EXPLANATION OF HORIZONTAL SECTION OF RAILWAY BALLAST QUARRY NEAR GOSFORD.

- No. 1.—Ripple-marked flaggy sandstone and mudstone.
- No. 2.—Clay ironstone, very argillaceous.
- No. 3.—Ripple-marked flaggy sandstone and mudstone.
- No. 4.—Ferruginous sandstone.
- No. 5.—Ripple-marked flaggy sandstone and mudstone.
- No. 6.—Sandstone.
- No. 7.—Lenticular band of pebbles, 2 in. in diameter.
- No. 8.—Laminated mudstone and sandy shales, dark purplish-grey. Fish
and Labyrinthodont remains found here.
- No. 9.—Laminated clayey-sandstone.
- No. 10.—Sandstone, with lenticular band of pebbles $\frac{1}{2}$ to 2 in. in diameter;
dark quartz, jasperoid quartz, white quartz, greenish felsites (?),
and mudstone.
- No. 11.—Sandstone.
- No. 12.—Lenticular grey shale.
- No. 13.—Sandstone.

Vertical scale, 10 feet to 1 inch.

EDITOR'S PREFACE.

THE present Memoir on "The Fossil Fishes of the Hawkesbury Series at Gosford," in this Colony, by my former Colleague, Mr. Arthur Smith Woodward, F.G.S., F.Z.S., of the Department of Geology and Palæontology, Natural History Branch of the British Museum, forms No. 4 of the Palæontological Series of the Survey Memoirs.

It is satisfactory to find that the Triassic age, hitherto assigned to our Hawkesbury-Wianamatta Series, gains further support from Mr. Woodward's study of the Gosford Fish.

Mr. T. W. Edgeworth David, B.A., F.G.S., Geological Surveyor, has supplied a Chapter on the Stratigraphy of the beds as displayed at Gosford, and an Index to the Genera and Species, Contents, and List of Plates, &c., has been added by myself.

The Collection was made by Mr. Charles Cullen, Collector to the Survey.

R. ETHERIDGE, JNR.

Sydney, March, 1890.

I.—INTRODUCTION.

THE discovery of an early Mesozoic Fish-fauna in the Hawkesbury-Wianamatta beds of New South Wales is of considerable importance, not only from the stratigrapher's point of view, but also from the standpoint of philosophical Palæontology. Some slight information has already been obtained concerning the fishes of the supposed Trias and associated deposits of India, South Africa, and North America, as compared with the tolerably well-known fish-fauna of the equivalent formations in Europe; and it is thus of great interest to be able to study, in the light of known facts, corresponding fossils from another distant region. The series of nearly four hundred specimens, which form the subject of the present Memoir, were obtained from a layer of dark grey shale, four feet thick, interstratified with the massive beds of sandstone belonging to the Hawkesbury formation at Gosford, New South Wales; and though the majority of the fossils are too imperfectly preserved to exhibit many details of structure, almost all are capable of precise determination. In nearly every case, the substance of the bones and ganoid scales has disappeared, nothing being distinguishable except mineral-stained impressions.

The first scientific notice of the Hawkesbury fishes appears to be a brief paper by Professor J. D. Dana,* who made known a single species of a peculiar Palæoniscid genus, *Urosthene*s, from Newcastle, on the Hunter River; and fifteen years later, Sir Philip de Malpas Grey Egerton † added further notes upon this fossil, while describing five other specimens from Cockatoo Island, Parsonage Hill, near Parramatta, and Chapel Hill, near Campbelltown. The last-named specimens were discovered by the late Rev. W. B. Clarke, who forwarded two to Sir Philip, with photographs of the three others; and these furnished one new genus and species of Palæoniscidæ (*Myriolepis Clarkei*), in addition to a supposed species of *Palæoniscus* itself

* J. D. Dana, "Fossils of the Exploring Expedition under the command of Charles Wilkes, U.S.N." Amer. Journ. Sci., 1848, [2] Vol. v, pp. 433, 434.

† Sir Philip de Malpas Grey Egerton, "On some Ichthyolites from New South Wales, forwarded by the Rev. W. B. Clarke," Quart. Journ. Geol. Soc., 1864, Vol. xx, pp. 1-5, Pl. i.

(*P. antipodeus*), and another new genus and species (*Cleithrolepis granulatus*), now known to pertain to the Dapedioid section of the Semionotidæ. Of *Urostheneis australis*, Dana, and *Palæoniscus antipodeus*, Egerton, there appear to be no representatives in the Geological Survey Collection sent to me; but of the other genera examples are numerous and satisfactorily preserved.

The discovery of the present collection has already been placed on record by Prof. W. J. Stephens,* who has described Labyrinthodont remains from the same formation.

* W. J. Stephens, "On some Additional Labyrinthodont Fossils from the Hawkesbury Sandstone of New South Wales," Proc. Linn. Soc. N.S.W., 1887, [2] Vol. ii, p. 156.

II.—DESCRIPTION OF THE GENERA AND SPECIES.

Class—Pisces.

Order—SELACHII.

Family—CESTRACIONTIDÆ.

Genus non det.

Obs.—An imperfect fossil, 0·33 in length, indicates the presence of a Selachian in the Hawkesbury beds, but does not exhibit sufficiently characteristic features for its generic determination. Each of the two dorsal fins of the fish is armed with a formidable spine; and the body is evidently covered with dense shagreen. The first dorsal fin-spine is much arched and sharply pointed, measuring 0·06 in length, and about 0·008 in breadth at the base; and there are some faint appearances of tubercles, suggesting a surface-ornament of longitudinal nodose ribs. The second dorsal spine is placed 0·175 behind the first, but only the base is preserved. The shagreen-granules are deeper than broad; and these seem to have been transversely ribbed or pectinated.

The discovery of satisfactory specimens of this Shark will prove of much interest, for the few features discernible—especially the characters of the shagreen—are very suggestive of a British Carboniferous Selachian, *Sphenacanthus*.* Teeth indistinguishable from the late Palæozoic *Diplodus* occur in the English Keuper†; the dorsal fin-spine, *Nemacanthus*, of the Rhætic has the posterior denticles laterally placed, as in all Palæozoic spines; and the Rhætic teeth, named *Hybodus minor*, have the base so much horizontally expanded that they would be assigned to *Cladodus* if found in the Carboniferous. But no undoubted proof of a Palæozoic Selachian genus

* L. Agassiz, *Recherches sur les Poissons Fossiles*, 1837, Vol. iii, p. 23. Provisionally defined in the Catalogue of the Fossil Fishes in the British Museum, 1889, Part I, p. 241.

† Smith Woodward, "On *Diplodus Moorei*, sp. nov., from the Keuper of Somersetshire," *Ann. Mag. Nat. Hist.*, 1889 [6], Vol. iii, pp. 299, 300, Pl. xiv, figs. 4, 5.

surviving in the Mesozoic has hitherto been obtained ; and the Hawkesbury genus will be noteworthy, if future discoveries confirm the impressions derived from the fossil just described.

Order.—DIPNOI.

Family.—UNCERTAIN.

Genus—GOSFORDIA, *gen. nov.*

Gen. Char.—Head very small ; snout pointed ; trunk elongate, though comparatively deep, laterally compressed ; median fin continuous ; pelvic fins acutely lobate, biserially fringed ; scales very small, delicate, overlapping, marked by fine striæ.

Obs.—Though thus imperfectly known, the generic distinctness of this fish from all other Dipnoans as yet sufficiently defined seems tolerably evident. If *Phaneropleuron* belongs to the Dipnoan order, it is readily distinguished by the separate anal fin ; and the only other genera with which it seems necessary to institute comparisons are *Conchopoma*,* *Ctenodus*,† and the recent *Ceratodus*.‡ All of these have the continuous median fin, and exhibit several striking features of resemblance to the Hawkesbury fish ; but a detailed comparison of the new fossil shows that it cannot be comprised in either of them.

The scales of *Conchopoma* are certainly very similar to those of *Gosfordia*,§ and the absence of traces of teeth in the original of Pl. I, Fig. 1, suggests that they may have been comparatively small in the Australian fish, as in the European Permian genus. The head, however, is relatively so much less in *Gosfordia* than in *Conchopoma*, and the operculum so different in shape, that other features, yet to be discovered, will doubtless combine to render the generic distinctness of these two forms most marked.

Ctenodus, and the living fish named *Ceratodus*, are both separated by the large size of the scales ; but it still remains to be decided whether or not

* R. Kner, "Ueber *Conchopoma gadiforme*, nov. gen. et spec.," Sitzungsab. math. Naturw. Cl. k. Akad. Wiss., 1868, Vol. lvii, Pt. i, pp. 278-290, Pls. i-iv.

† The latest memoir upon this genus is by Anton Fritsch, "Die Lurchfische, Dipnoi," forming Pt. 3 of Vol. ii of the "Fauna der Gaskohle, etc., Böhmens" (1888).

‡ A. Günther, "Description of *Ceratodus*," Phil. Trans., 1871, pp. 511-571, Pls. xxx-xlii.

§ The writer has been able to verify this fact by a personal examination of the type-specimens of *Conchopoma* in Berlin and Strassburg.

the fossil teeth originally termed *Ceratodus**, truly pertain to the fish now described. Though an imperfect tail of the early Mesozoic *Ceratodus* has already been made known,† and a tolerably complete skull briefly noticed,‡ there is yet no decisive proof of the generic identity of the extinct and living species; and future discoveries may thus eventually relegate *Gosfordia* to the synonymy of *Ceratodus* proper, and justify the adoption of a new name for the existing fish of the Queensland rivers.

GOSFORDIA TRUNCATA, sp. nov.

Pl. I; Pl. II, Figs. 1, 2.

Obs.—Of this genus and species no complete fish is known; but, in addition to less satisfactory fragments, the following series of specimens exhibits many of the chief features in its skeletal anatomy:—

- (a) Head and anterior portion of the trunk, shown of one-half the natural size in Pl. I, Fig. 1.
- (b) The greater portion of the trunk to the tip of the tail, shown of one-half the natural size in Pl. II, Fig. 1. This and the preceding are the type-specimens.
- (c) A portion of the axial skeleton of the trunk.
- (d) Terminal portion of the trunk, with the median fin and one of the pelvic pair, shown of the natural size in Pl. I, Fig. 2.
- (e) Fragment, with fin-rays (Pl. II, Fig. 4).

General Form.—The head is remarkably small and triangular. Immediately behind it, the trunk rapidly deepens, and in the original of Pl. I, Fig. 1, the maximum width of the crushed head (0·08) becomes no less than 0·19 at a point 0·17 distant nearer the tail. The total length of a fish of these proportions is probably not less than 0·6, and its lateral compression is indicated by the invariable display of a side-view in the fossils.

Head and Opercular Apparatus.—The only specimen exhibiting the head (Pl. I, Fig. 1), is in a very imperfect state of preservation, and does not admit of the determination of any structural features. Its relatively small proportions, however, are well shown. A faint groove and ridge (*x*) mark

* L. Agassiz, *Rech. Poiss. Foss.*, 1838, Vol. iii, p. 129.

† *Celacanthus giganteus*, T. C. Winkler, *Archiv. Mus. Teyler*, 1890, Vol. v, pp. 141–147, Pl. ix.

‡ D. Stur, "Vorlage des ersten fossilen Schädels von *Ceratodus* aus den obertriassischen Reingrabner Schiefer von Pölzberg nördlich bei Lunz," *Verh. k.k. Geol. Reichsanst. Wien*, 1886, pp. 381–383.

the posterior margin either of the opercular bones or the pectoral arch; a hollow (*orb.*) seems to indicate the position of the orbit; the roof of the skull is flattened, and the snout is sharply pointed. No teeth are distinguishable, and it seems likely that they were small.

Axial Skeleton of Trunk.—The notochord, as usual, was persistent; and the cartilages of the neural and hæmal arches and spines—as also the interspinous cartilages—were evidently only superficially calcified, these being often represented in the fossils by a large core of calcite surrounded by a thin film of skeletal matter, well shown in the figures. The neural arches and spines are short and stout; and in the caudal region the hæmal arches and spines are similar. Long, slender, gently arched ribs are well shown in the abdominal region, arranged in series as far as its termination almost immediately above the pelvic fins; and in the type specimens there are about three pairs of these ribs in the space of 0·02.

Appendicular Skeleton.—Of the paired fins, only one of the pelvics is preserved (Pl. I, Fig. 2, *plv.*); and a few robust fin-rays exhibited by a fragmentary fossil (Pl. II, Fig. 2) may pertain either to these fins or to the pectoral pair. Each pelvic fin is acutely lobate, its length being more than three times as great as its maximum breadth; and the long lobe is fringed in the usual manner with stiff fin-rays. The median fins form a continuous fringe round the hinder end of the body and are supported by a double series of interspinous bones, the elements of the proximal series being about twice the length of the distal. The interspinous bones appear to be even stouter than the neural and hæmal spines to which they are apposed; and those of the proximal series, at least, have broadened ends.

Squamation.—The tissues of the body have become converted into a black granular material, and the scales being very delicate, they are thus only recognizable with difficulty. The precise outlines of the scales cannot be distinguished in any specimen; but they are evidently very small, and all are marked by fine longitudinal striations.

Order—GANOIDEI.

All the fishes of the Hawkesbury-Wianamatta Series referable to the hyostylic type, with true bones, fall under the denomination of Ganoidei, as defined and determined by Agassiz. In the prevailing uncertainty as to the correct limits and nomenclature of the great groups of fishes of this type, we

simply adopt the term for convenience, awaiting the further development of palæontological research to confirm or modify the apparently now reasonable classification of Cope.*

The subdivisions of the Ganoids are still equally under dispute, and it will suffice for the present Memoir, which deals only with actinopteran families (*i.e.*, those in which the paired fins are non-lobate), to distinguish between that type in which the interspinous bones of the median fins are fewer in number than the apposed dermal fin-rays, and the more specialized type in which each fin-ray has a separate support. As remarked, especially by Cope,† the stages presented by the development of the appendicular skeleton, are of great taxonomic significance; and it may now be regarded as proved, that the "crossopterygian" limb and the non-correspondence of the ends and exo-skeleton in the median fins are marks of inferiority of generalization. The heterocercal tail likewise persists in many cases until the "actinopteran" limb has been developed (*Palæoniscidæ*); but as soon as there is a tendency towards the correlation of the interspinous bones and the median fin-rays, the upper lobe gradually atrophies and externally disappears.

A.—Ganoids in which the dorsal and hæmal interspinous bones are less numerous than the apposed dermal fin-rays.

(i).—Caudal fin heterocercal.

Family—**PALÆONISCIDÆ.**

Fam. Char.—Body elongate, fusiform; scales, when present, rhombic (rarely in part cycloidal), enamelled; dorsal fin rarely remote. Head-bones well-developed, externally enamelled; eye far forwards, and snout prominent; mandibular suspensorium more or less oblique, and the mouth deeply cleft. A series of broad branchiostegal rays, the most anterior pair especially large, with a small median element.

Genus—**MYRIOLEPIS**, *Egerton*, 1864.

(Quart. Journ. Geol. Soc., Vol. xx, p. 3.)

Gen. Char.—Head large, snout obtuse; suspensorium oblique; gape very wide, with the teeth large and conical; fins well-developed, the dorsal high and triangular in form, placed opposite the space between the pelvis

* E. D. Cope, "Observations on the Systematic Relations of the Fishes," *Proc. Amer. Assoc. Adv. Sci.*, 1871, p. 328.

† E. D. Cope, Review in *Amer. Naturalist*, 1887, p. 1015.

and the anal; anal fin also short and triangular; upper lobe of tail much produced, the caudal fin being powerful and deeply forked; small fulcra present upon all the fins. Scales very small [superficially striated, *Egerton*]; large oat-shaped scales, finely striated, upon the sides of the caudal lobe, and prominent fulcral scales upon its upper border.

Obs.—This genus was founded by Sir Philip Egerton upon the middle portion of a fish destitute of fins, from Chapel Hill, near Campbelltown, and upon the anterior half of another similar fish from Cockatoo Island, only known to him by a photograph transmitted by the Rev. W. B. Clarke. The characters, so far as discernible, were considered to denote a close relationship with *Arolepis*, thus placing the genus in the family of the Palæoniscidæ; and this interpretation has subsequently been generally adopted. The specimens in the present collection now render it possible to complete the diagnosis as given above; and, though exhibiting but few anatomical details, they make known the general features of at least two well-marked species.

A careful study of the new fossils suggests the comparison of *Myriolepis* with *Thrissonotus*,* from the Lower Lias of Lyme Regis, Dorsetshire, the only essential difference in the single known specimen of the English Liassic genus being the considerable elongation of the anal fin.

MYRIOLEPIS CLARKEI, *Egerton*.

Pl. II, Figs. 3, 4; Pl. III, Figs. 1.

Myriolepis Clarkei, Egerton, Quart. Journ. Geol. Soc., 1864, vol. xx., p. 3, Pl. I, fig. 1.

Obs.—The type species is represented by several fossils, pertaining both to old and young individuals, and the information afforded by the following five specimens is of especial value:—

- (a) A large complete fish, probably about 0·435 in length, and shown of half the natural size in Pl. II, Fig. 3. (The specimen has been broken across, immediately behind the pelvic fins, and the wrong halves of the counterpart unfortunately united, leaving a gap in the middle that did not exist originally. The figure is thus in part restored, with the help of Egerton's drawing already quoted.)

* Sir Philip de M. Grey Egerton, "Figures and Descriptions of British Organic Remains," Mem. Geol. Surv. Gt. Brit., 1858, Dec. ix, No. 2, Pl. ii.

- (b) Head and pectoral fin of a smaller individual, shown of the natural size in Pl. III, Fig. 1.
- (c) Imperfect head and trunk of a small individual, 0.215 in length.
- (d) Dorsal fin of a large individual, shown of the natural size in Pl. II, Fig. 4.
- (e) Caudal pedicle, with portions of the caudal and anal fins.

General Form.—The largest specimen (Pl. II, Fig. 3), measures at least 0.435 in length, and of this the head and opercular apparatus extend about 0.09. The trunk is of almost uniform depth as far as the dorsal fin, equalling perhaps 0.095; and the caudal region gradually tapers to a stout caudal pedicle, produced terminally into a large upper lobe. All the fins are large and powerful.

Head and Opercular Apparatus.—Nothing can be discerned of the cranial bones or the suspensorium, but the marked obliquity of the latter is indicated both in Pl. II, Fig. 3, Pl. III, Fig. 1, and in No. c. The deeply cleft character of the gape is also very evident, and some indications of the elements of the upper jaw are observable in the second fossil. A very short tooth-bearing element, probably the premaxilla, occurs in front, at the extremity of the snout (Pl. III, Fig. 1, *pmx.*); and a large narrow, but gradually widening, impression behind seems to be due anteriorly to the maxilla (*mx.*), and posteriorly to the palato-pterygoid arcade, the former half being provided with small conical teeth like those of the premaxilla. The lower jaw is somewhat shorter than the upper; but the dentary element (*d*) is relatively long and slender, and this bears a few widely-spaced conical teeth of larger size than any exhibited in the opposing dentition.

Behind the head, indications of the opercular apparatus are observed, of comparatively small dimensions. Unless appearances in No. b (Pl. III, Fig. 1) are deceptive, the operculum (*op.*) is very small and triangular, while the suboperculum (*s.op.*) is at least twice as deep, quadrilateral, and of uniform breadth. Remains of some of the branchiostegal rays (*br.*) are preserved beneath, quite of the ordinary Palæoniscid character.

Appendicular Skeleton.—In all the fins, the rays are broad and much flattened, with a longitudinal median keel; and, except perhaps in front of the pectorals, they are articulated, and divide distally into fine filaments. In

each of the fins, except the caudal, the anterior rays are gently arched; and although distinct small fulcra can rarely be discerned, various indications prove the original presence of these structures. The pectoral fins are large and triangular, perhaps almost falcate; and the pelvic fins, of about half the size, exhibit a relatively long base-line, and are placed midway between the pectorals and the anal. The dorsal fin (Pl. II, Fig. 4) shows in front at least nine large basal fulcral rays, gradually increasing in length, and its base-line is greater than its height. The anal fin is slightly smaller than the latter, but equally elevated; and in the original of Pl. II, Fig. 3, a few of the small anterior fulcra can be distinguished. The caudal fin is deeply cleft, and the rays of the lower lobe are very closely articulated even near the proximal extremity.

Squamation.—The scales are extremely small, those of the flank, in an individual 0·435 in length, not measuring more than 0·0015 in depth and breadth. Ventrally, they become narrow, and upon the upper lobe of the tail oat-shaped or diamond-shaped; and Sir Philip Egerton describes them as externally sculptured by “two or three deep longitudinal sulci.” The present specimens, however, are too imperfectly preserved to exhibit any scale ornament, except faint striations upon the investment of the upper caudal lobe; and the only ridge-scales to be observed occur upon the superior border of this prolongation, where they are very prominent, and pass upwards into the fin-fulcra.

MYRIOLEPIS LATUS, *sp. nov.*

Pl. III, Figs. 2, 3.

Obs.—A second species of *Myriolepis* is indicated by a small series of specimens, of which the following three are the most important:—

- (a) The complete head and trunk, wanting all fins, except the anal and caudal, to be regarded as the type-specimen, and shown slightly reduced in Pl. III, Fig. 2.
- (b) The greater portion of the head and trunk, lateral aspect, with fragments of the pectoral, pelvic, and anal fins, the former in the relative positions indicated in dotted outline in the figure of No. *a*.
- (c) Portion of the head and anterior portion of the trunk, showing the left infraclavicle, outer aspect. (Pl. III, Fig. 3.)

General Form.—The type-specimen (Pl. III, Fig. 2) measures 0.265 in length, and is perhaps as large as any indicated in the collection. Compared with *M. Clarkei*, the fish is much less elongated, the greatest depth of the trunk being only comprised a little more than three and a half times in the total length, the fins are less powerful, and the scales are exactly twice as large in proportion.

Head and Opercular Apparatus.—No details of cranial osteology can be deciphered, and little beyond the general form of the head is determinable. In accordance with the other proportions of the fish, it is relatively shorter than in *M. Clarkei*, and the mandible perhaps stouter. An element of the upper jaw, either the maxilla or the palato-pterygoid, is long and narrow, though deepest behind, and remains of the actual maxilla in No. c show that it was externally ornamented by large rugæ and tubercles. The dentary bone, bearing at least a few spaced conical teeth, is superficially ornamented by striations parallel to its long axis.

Appendicular Skeleton.—At the postero-inferior angle of the lower jaw in No. c, a large, elongated, triangular bone is observed, evidently to be regarded as the left infraclavicular element of the pectoral arch. This bone is shown of twice the natural size in Pl. III, Fig. 3, the short base-line being posteriorly and the apex anteriorly directed, and its external surface is ornamented by coarse, rounded, radiating rugæ, proceeding upwards and downwards from an unsymmetrically-placed longitudinal ridge. The form and proportions of the other bones of the pectoral arch cannot be determined, and in the figure of the type-specimen (Pl. III, Fig. 2) the positions of the paired fins can only be partially marked by dotted lines, based upon the evidence of a second fossil, No. b. None of the fins are capable of description, but, so far as determinable, they agree well with those of *M. Clarkei*.

Squamation.—The size of the scales renders it easily possible to observe their variations in form. Upon the flanks they are deeper than broad, and in a specimen 0.265 in length, the antero-posterior measurement of each is about 0.002. Ventrally, all the scales become much broader than deep, and upon the upper lobe of the tail they are diamond-shaped and elongated. There is also a singular feature, well displayed in the type-specimen (Pl. III, Fig. 2), immediately above the anal fin, about nine series of scales being reflexed forwards, as in the *Platysomidæ*.

Genus—APATEOLEPIS, *gen. nov.*

Gen. Char.—Body slender; head of moderate size; snout prominent; suspensorium very oblique, and gape wide; teeth minute. Fins well-developed; the dorsal very high, triangular in form, with a short base-line placed opposite the space between the pelvics and the anal; anal fin also triangular, with a short base-line; upper lobe of tail much produced, the caudal fin being powerful and deeply forked; fulcra absent. Scales of the trunk rhomboidal, extremely delicate, marked by two or three diagonal ridges; those upon the sides of the upper lobe of the tail thicker, oat-shaped, similarly ornamented; a prominent fulcral series upon the superior margin of the caudal lobe.

Obs.—This new genus of Palæoniscidæ may appropriately receive the name of *Apateolepis*, in allusion to the deceptive character of its squamation. The scales of the whole of the body except the upper caudal prolongation, are so delicate that they are either only imperfectly preserved, or completely destroyed; and the latter is so often the case, that one might at first sight suspect a resemblance to the extinct *Chondrosteus* and the modern *Polyodon*, in having the squamation exclusively confined to the caudal lobe.

Only two Palæoniscidæ of a similar type seem to have been hitherto discovered; and it is interesting to know that both of these agree with the present form in the singular absence of fin-fulcra. The first genus is that described by Dr. Traquair, from the Lower Carboniferous of Eskdale, Dumfriesshire (Scotland), under the name of *Phanerosteon**; and the second is a fish from the Erie Shale of Ohio, more recently briefly noticed by Dr. Newberry under the name of *Actinophorus*†. According to Dr. Traquair, *Phanerosteon* was quite destitute of scales upon the flank, with the exception of a few thin examples immediately behind the pectoral arch; and this genus is still further distinguished from *Apateolepis* by the character of the dorsal fin, and the less pronounced bifurcation of the caudal. *Actinophorus* is a long, slender fish, with pointed head, attaining a much greater size than either of the foregoing; and though the whole of the flank is covered by thin quadrangular scales, these, according to the definition, will differ from those of *Apateolepis* at least in their narrowness.

* R. H. Traquair, "Report on Fossil Fishes collected in Eskdale and Liddesdale," Trans. Roy. Soc. Edinburgh, 1881, Vol. xxx, pp. 39-43, Pl. iii, figs. 6-8.

† J. S. Newberry, "The Fish Fauna of the Erie Shale of Ohio," Trans. New York Acad. Sci., 1888, Vol. vii, No. 7.

APATEOLEPIS AUSTRALIS, *sp. nov.*

Pl. IV, Figs. 1-4.

Obs.—All the examples of *Apateolepis* hitherto met with in the Hawkesbury beds are referable to a single species, of which the following specimens exhibit some of the principal characters:—

- (a) Nearly complete fish, wanting the paired fins, shown of the natural size in Pl. IV, Fig. 1. (Type specimen.)
- (b) Imperfect fish, viewed in part from the ventral aspect, displaying portions of all the fins, and shown of the natural size in Pl. IV, Fig. 2.
- (c) Specimen in counterpart, showing the greater portion of the fish, with remains of all the fins, and faint indications of long slender neural arches and spines.
- (d) Tail, shown of the natural size in Pl. IV, Fig. 3.
- (e) Fragment showing flank-scales, of which some are enlarged six times in Pl. IV, Fig. 4.

General Form.—The type-specimen measures about 0·18 in total length, and about 0·03 in maximum depth, the trunk being thus comparatively slender, and more than four times as long as the head with the opercular apparatus. The upper lobe of the tail is much elongated, though robust. The dorsal fin is placed over the posterior portion of the pelvic pair, and well in advance of the anal.

Head and Opercular Apparatus.—That the head is typically that of a Palæoniscid is evident; but no precise details of structure are capable of determination. In the type-specimen (Pl. IV, Fig. 1), an element of the upper jaw is faintly indicated, and may probably be regarded as the pterygo-palatine arcade (*pt. pl.*); and in the same fossil, the mandible is imperfectly shown, being probably somewhat broken in front and artificially deepened by crushing. A longitudinally-striated element, evidently the dentary (*d*), is recognizable; and there are traces of minute teeth in both jaws. The operculum (*op.*) is small, quadrangular, and irregularly rhomboidal in form; and the suboperculum (*s. op.*) is a somewhat larger bone, exceeding the operculum in breadth, if not also in depth.

Axial Skeleton of Trunk.—In most examples of *A. australis*, there is distinct evidence of the persistence of the notochord, and in some specimens

(e.g., Nos. *a* and *c*) indications of long, slender neural arches and spines can be distinguished. As usual among the Palæoniscidæ, there is no evidence of ribs; and the only remains of hæmal arches are four stout bones, with slightly expanded extremities, supporting the lower lobe of the caudal fin in the type-specimen (Pl. IV, Fig. 1).

Appendicular Skeleton.—Of the pectoral arch, the supraclavicle, clavicle, and infraclavicle are shown also in the type-specimen (Pl. IV, Fig. 1). The supraclavicle (*s. cl.*) is nearly four times as long as its maximum breadth; the upper extremity is narrowest, and immediately below this is a slight rounded excavation of the posterior margin, whence the bone very gradually expands downwards and is radiately striated. The clavicle (*cl.*) is bent forwards as ordinarily, at a point much nearer the inferior than the superior extremity, and there is either a flexure or thickening of the anterior concave margin. The ascending limb is pointed above, narrow, with the hinder margin gently curved, and the surface is marked by fine striæ not precisely parallel to its long axis, but slightly sloping forwards; the lower limb is short, broad, and expanded, and exhibits similar but radiating striæ. The infraclavicle is a large triangular bone, elongated antero-posteriorly, and partly seen beneath the posterior portion of the mandible; a longitudinal ridge traverses its superior portion, and from this below there radiate numerous coarse rugæ.

The pectoral fins are best shown in No. *b* (Pl. IV, Fig. 2), where one is of triangular form, and seems to be nearly complete, though comprising only about twenty rays. Of the "pelvic" bones there is no trace in any specimen; but the pelvic fins are well preserved in Nos. *b* (Pl. IV, Fig. 2) and *c*, and they were evidently of considerable size, though still somewhat smaller than the pectorals. Not less than thirty rays can be counted in one of these fins in No. *c*.

The median fins are all acuminate, and consist of numerous, closely apposed rays. Though apparently complete in the type-specimen (Pl. IV, Fig. 1), the dorsal and anal fins were probably somewhat larger than those of this fossil, another (Pl. IV, Fig. 2) exhibiting relatively longer rays in the anal, and a third (No. *c*) displaying a greater number of rays in both fins. In the type, the dorsal fin comprises about forty-five rays, and the anal not more than thirty-five, whereas in No. *c*, the corresponding numbers are at least sixty and forty; but in either case, the dorsal appears to be the larger

fin of the two, and is placed entirely in advance of the anal. In the dorsal fin, the most anterior rays gradually increase in length to the twelfth, which is longest, and the rapid shortening of those that follow is such as to make the posterior margin much more abrupt than the anterior; in the anal fin, the maximum length is attained by about the ninth ray, and the shortening of the rays in either direction is precisely like that observed in the dorsal. Each of these fins is distinctly supported by a series of stout interspinous bones, with somewhat expanded extremities, much less numerous than the rays; the anal fin of the type-specimen exhibiting only ten bones apposed to at least twenty-five of the rays.

The caudal fin (Pl. IV, Figs. 1, 3) is deeply forked, and the lower lobe consists of about forty rays.

All the fin-rays are delicate, laterally compressed, and articulated at more or less distant intervals; and many, if not all, are bifurcated distally. In the best preserved fins there are no indications even of minute fulcra.

Squamation.—The scales of the flanks are extremely delicate, rhomboidal in form, as deep as broad, and ornamented by two prominent diagonal ridges, which are not parallel, but often meet in front and are most widely separated mesially. In most specimens the obscure remains of these ridges constitute the only evidence of the original presence of scales; but one small fossil, No. *e*, is more satisfactory, and a few of the actual scales are shown, of six times the natural size, in Pl. IV, Fig. 4. The scales upon the sides of the upper caudal lobe (Pl. IV, Figs. 1, 3) are much thicker than those of the remainder of the body. They also exhibit the characteristic oat-shaped form, and are diagonally ridged.

(ii)—Caudal fin semi-heterocercal.

Family—CATOPTERIDÆ.

Fam. Char.—Body elongate; scales rhombic, enamelled; dorsal fin remote; head-bones well developed, externally enamelled; eye far forwards, and snout prominent; suspensorium oblique, and mouth deeply cleft.

Obs.—The genera *Catopterus*, Redfield,* and *Dictyopyge*, Egerton,† have been associated in recent years with *Acentrophorus* and *Semionotus*

* J. H. Redfield, "On the Fossil Fishes of Connecticut and Massachusetts," Ann. Lyc. Nat. Hist. New York, 1848, Vol. iv, p. 37, Pl. i.

† In C. Lyell, "On the Structure and Probable Age of the Coal-field of the James River, near Richmond, Virginia," Quart. Journ. Geol. Soc., 1847, Vol. iii, p. 276.

(=*Ischypterus*), as the forerunners of the Lepidosteoidei, in which there is no infraclavicle, and in which the rays of the median fins correspond in number with their supporting ossicles. It is unfortunate, indeed, that the state of preservation of the known specimens does not permit of these characters in the osteology being clearly ascertained; but a study of the new fossils from the Hawkesbury beds, in the light of examples already described from the European and American Trias, is so suggestive of intimate relationship with the Palæoniscidæ, that we venture to suggest an emendation of the now-accepted arrangement of these fishes.

If Mr. Dinkel's drawings of *Dictyopyge macrura** be correct, the number of the fin-rays in the anal fin is distinctly greater than that of the supporting interspinous bones; and the fish is therefore excluded, by accepted definitions, from the "Lepidosteoidei," and falls with the Palæoniscidæ into the "Acipenseroidei" (Traquair), or "Heterocerci" (Zittel). One of the Australian fossils (*D. illustrans*, Pl. IV., Fig. 7) exhibits a large triangular bone beneath the back of the mandible, which seems most satisfactorily compared with the Palæoniscid infraclavicle; and the vaguely discernible features of the head also bear a very striking resemblance to the corresponding parts in the Palæoniscidæ. Moreover, the tail in the new specimens (Pl. IV., Fig. 9) is slightly more heterocercal than has hitherto been observed in this genus.

It is therefore proposed to place *Catopterus* and *Dictyopyge* in a distinct family, the Catopteridæ to be assigned to whatever great subdivision of the "Ganoids" is made to include the Palæoniscidæ and their allies.

Genus—DICTYOPYGE, Egerton, 1847.

(Quart. Journ. Geol. Soc., vol. iii., p. 276).

Gen. Char.—Head small, or of moderate size; gape very wide; teeth minute and conical. Fins with distinct fulcra; dorsal opposite to, or immediately in advance of the anal; caudal fin forked. Scales rhombic, as deep as broad upon the flank, broader than deep ventrally, the exposed surface smooth, or with few oblique ridges or furrows. Ridge-scales absent.

Obs.—As remarked by Traquair,† *Dictyopyge* is only distinguished from *Catopterus*, so far as known, by the position of the dorsal fin;

* Quart. Journ. Geol. Soc., Vol. iii., Pl. viii., Pl. ix., fig. 1.

† R. H. Traquair, "On the Agassizian Genera *Amblypterus*, *Palæoniscus*, *Gyrolepis*, and *Pygopterus*," Quart. Journ. Geol. Soc., 1877, Vol. xxxiii, p. 567.

this appendage in the former genus being partly in advance of, or directly opposed to, the anal fin, while in *Catopterus* it arises opposite the hinder portion of the anal, or is completely behind. Such a character may be provisionally regarded as sufficient for generic distinction; and of *Dictyopyge*, as thus defined, five species are already known. These have been obtained from the Trias of Virginia, U.S.A.,* and of Tyrone, Ireland,† the Bunter of the Rhine Valley,‡ the Keuper Sandstone of Coburg, Germany,§ and the Upper Keuper Sandstone of Warwickshire, England.||

The most important descriptions of the genus are those of Traquair (*loc. cit.*) and Strüver (*loc. cit.*); and the fossils from the Hawkesbury beds do not add any very definite information concerning new structural features, although, as observed above, some appearances are suggestive of interesting novel points, to be verified or disproved by future discoveries. One fact, however, seems certain, namely, that Strüver's restoration of *D. socialis* is incorrect in representing the mandibular suspensorium as vertical or even inclined forwards, all specimens that the writer has examined, whether European, American, or Australian, exhibiting a suspensorium as much inclined backwards as in many specialized Palæoniscidæ.

DICTYOPYGE SYMMETRICA, *sp. nov.*

Pl. IV, Figs. 5, 6.

Obs.—The smallest of the Australian species of *Dictyopyge* is represented by specimens exhibiting but few details of structure, and the following four examples show all the features discernible:—

- (a) Type-specimen (Pl. IV., Fig. 5.)
- (b) Nearly complete fish, wanting the upper half of the caudal fin (Pl. IV., Fig. 6.)
- (c) Complete trunk, wanting paired fins.
- (d) A smaller fish, showing parts of the fins, especially the pectoral.

* *Dictyopyge macrura*, Egerton, *loc. cit.* *Catopterus macrurus*, W. C. Redfield, Amer. Journ. Sci., 1841, Vol. xli, p. 27, and Proc. Amer. Assoc. Adv. Sci., 1856, pp. 180-188.

† *D. catopterus*, R. H. Traquair, Quart. Journ. Geol. Soc., 1877, Vol. xxxiii, p. 565. *Palæoniscus catopterus*, Egerton, *ibid.*, 1850, Vol. vi, p. 4.

‡ *D. rhenana*, W. Deecke, Palæontographica, 1889, Vol. xxxv, p. 107, Pl. vi, fig. 11.

§ *D. socialis*, Berger, sp., described by J. Strüver, "Die fossilen Fische aus dem Obern Keupersandstein von Coburg," Zeitschr. deutsch. Geol. Ges., 1864, Vol. xvi, pp. 322-329, Pl. xiii, fig. 2.

|| *D. superstes*: *Palæoniscus superstes*, Egerton, Quart. Journ. Geol. Soc., 1858, Vol. xiv, p. 164, Pl. xi.

General Form.—The trunk is slender, and the head, with the opercular apparatus (if completely preserved in No. *b*), occupies less than one-fourth the total length of the fish. The dorsal fin appears precisely opposite the anal, and approximately equal to it in size; and the caudal fin is deeply forked.

Head and Opercular Apparatus.—The snout is obtuse, the eye large, and the mandible apparently slender. It may also be noted that some, at least, of the head bones are ornamented by superficial striæ; but nothing further can be observed of the structure of these parts.

Appendicular Skeleton.—In all the fins the rays are robust, but very closely arranged, and bifurcating distally, and small fulcra are prominent on the anterior margin of each. In No. *d*, the pectorals have relatively long rays, extending more than half the distance to the pelvic pair. The latter, well shown in Pl. IV, Fig. 6, are powerful, consisting of at least eight or nine distally-bifurcating rays; and there are four slender basal fulcra in front, passing downwards into the small fulcral fringe of the first ray. The dorsal and anal fins are nearly equal and opposite, suggesting the specific name of the fish; but the number of rays is greatest, as usual, in the anal, being here about sixteen or twenty. The anterior fulcra (Pl. IV, Fig. 5*a*) are similar to those of the pelvic fins.

Squamation.—The scales are ornamented with faint oblique ridges or grooves, and the narrowing of the ventral series is very conspicuous in all the specimens. In No. *c*, the scales of the anterior portion of the flank are somewhat deeper than broad; and each appears to have an inner vertical keel, mesially placed.

Remarks.—In the position of the dorsal fin, and in general proportions, this species closely resembles *D. macrura*, *D. superstes*, and *D. socialis*. It differs from the first in its smaller size, and both from this and the second in the presence of ornamentation upon the scales; it is also distinguished from *D. socialis* by its smaller size and the less robust character of the caudal pedicle.

DICTYOPYGE ILLUSTRANS, *sp. nov.*

Pl. IV, Figs. 7-9.

Obs.—The most abundant and best preserved species is somewhat larger than the foregoing, and may be appropriately named *D. illustrans*, in

allusion to its possession of certain features probably destined to shed new light upon the precise affinities of the genus. Five specimens exhibit its principal characters:—

- (a) Type-specimen (Pl. IV, Fig. 7).
- (b) A more imperfect fish, partly distorted (Pl. IV, Fig. 8).
- (c) Another example, of similar size and proportions, in counterpart.
- (d) A fish with the well-preserved tail shown, of twice the natural size (Pl. IV, Fig. 9.)
- (e) An imperfect small specimen, 0·058 in length, in counterpart.

General Form.—The general form and proportions of the fish are well shown in the type-specimen (Pl. IV, Fig. 7). The trunk is relatively short and stout, the head, with the opercular apparatus, occupying almost a quarter of the total length, and the gape of the mouth is very wide. The dorsal fin is for the most part in advance of the anal; the upper lobe of the tail is conspicuously produced, and the caudal fin powerful (Pl. IV, Fig. 9).

Head and Opercular Apparatus.—Little can be discerned of the structure of the head, but in the type-specimen and No. *b* (Pl. IV, Figs. 7, 8), the forward position of the eye, and the obliquity of the mandibular suspensorium, are evident; and both in the first and other specimens there seem to be traces of minute conical teeth upon the margins of the jaws. The impression of an antero-posteriorly elongated bone upon the cheek is distinct (Pl. IV, Fig. 7, *x*), but indeterminable; and the external surface of all the elements is probably ornamented with fine striæ and tuberculations (No. *e*). The operculum (*op.*) and suboperculum (*s. op.*) are narrow; and, unless appearances are deceptive in the type, the former is much smaller than the latter.

Appendicular Skeleton.—The clavicle and supraclavicle are well shown in the type-specimen, the external striated surface of the former being narrower than that of the latter; and in the same fossil, immediately below the posterior portion of the mandible, an antero-posteriorly elongated triangular area is worthy of note. This feature, with a sharply-pointed anterior extremity and longitudinal mesial elevation, and, possibly, superficial rugæ, may well be interpreted as an infraclavicular element, though further evidence must be awaited before the determination can be affirmed as a fact.

Of the paired fins, the pectorals are indicated in No. *b* (Pl. IV, Fig. 8) by a few powerful rays; and in the same fossil the smaller pelvic fins apparently exhibit a long base-line. The dorsal and anal fins are elevated and triangular in form, and the first is placed almost entirely in advance of the second; the dorsal is also conspicuously smaller than the anal, the one, in the type-specimen, exhibiting about twenty rays, while the other has not less than twenty-eight. The basal fulcra are long and slender, passing upwards into the fine fulcral fringe upon the first ray, exactly as figured by Egerton in *D. superstes*.* The caudal fin is well shown, of twice the natural size, in Pl. IV, Fig. 9; it is robust and moderately forked. The rays are closely apposed and finely jointed, and there are distinct fulcra above and below.

Squamation.—The scales of the flank are at least as deep as broad, while those of the ventral series are twice as broad as deep. They are best seen in the type-specimen, and the posterior two-thirds of the surface of each is ornamented with sparse oblique markings, which may have originally been either grooves or ridges. In some of the flank-scales (Pl. IV, Fig. 7*a*), two of these markings are observed; in a few placed most anteriorly, there are perhaps three, sometimes wavy. The ventral scales (Pl. IV, Fig. 7*b*) have mostly only one such superficial mark. The small diamond-shaped scales upon the upper lobe of the tail have a single diagonal ridge or furrow, inclined forwards and downwards; and upon the superior margin of this short pointed lobe are a series of very large fulcral scales, passing upwards into the small fulcral fringe upon the edge of the fin.

Remarks.—*D. illustrans* differs from all known species except *D. catopterus* in the comparatively forward position of the dorsal fin; and it is readily distinguished from this species by the greater depth of the trunk and the smaller dimensions of the caudal fin.

DICTYOPYGE ROBUSTA, *sp. nov.*

Pl. III, Figs. 4, 5.

A very robust species referable to *Dictyopyge*, as here defined, is indicated by a few imperfectly preserved specimens, of which the following are characteristic:—

(*a*) Type-specimen (Pl. III, Fig. 4).

* Quart. Journ. Geol. Soc., Vol. xiv, Pl. xi, fig. 3.

- (b) A nearly complete trunk, with pelvic, dorsal, anal, and caudal fins.
- (c) A more imperfect trunk, with portions of the median fins, shown in Pl. III, Fig. 5.
- (d) Head and trunk, wanting the tail.
- (e) Nearly complete fish, wanting the pectoral, dorsal, and anal fins.

General Form.—The trunk is comparatively deep in the abdominal region, and the dorsal contour more arched than is usual in *Dictyopyge*. The head, with the opercular apparatus, occupies about one-quarter of the total length of the fish; and the snout seems to have been bluntly pointed. The dorsal and anal fins are long, and the former is placed partly in advance of the latter. The upper lobe of the tail is conspicuously produced.

Head and Opercular Apparatus.—None of the bony elements of the head and opercular apparatus can be distinguished, and only faint impressions of circumorbital bones exhibit the position and proportions of the eye. The mouth is large and deeply cleft, as usual, and in Nos. *d* and *e* appearances are suggestive of small, stout, conical teeth, placed in close series in the upper jaw. Some irregular superficial striæ are seen in No. *e*.

Appendicular Skeleton.—A gently arched, slender clavicle, with part of a more expanded supraclavicle, is shown in Pl. III, Fig. 5; and both of these elements exhibit superficial longitudinal striations. The pectoral fin, however, is not distinct in any specimen. The pelvic fins are of moderate size, each consisting of about seven rays, and placed nearer to the anal than to the pectorals. The dorsal and anal fins are both elongate, and of about equal size, the latter commencing at a point nearly opposite the middle of the former. In the type-specimens distinct fulcra are observed upon the anal fin, and the number of rays is about thirty, generally shortening and more widely spaced posteriorly. The caudal fin (No. *e*) is broad, powerful, and deeply forked.

Squamation.—Though always indistinct, the scales appear to have been superficially ornamented with a few short oblique ridges or furrows. Those upon the flank are at least as deep as broad, while those upon the ventral aspect are conspicuously broader than deep; and the scales upon the caudal pedicle are not excessively elongated. Appearances in some specimens are also suggestive, at first sight, of the presence of a series of dorsal ridge-scales;

but a careful examination of the fossils, and comparison with the examples of *Pristisomus*, which undoubtedly possess such scales, seem to demonstrate that in the species under discussion the markings are deceptive, and due to accident in preservation.

Remarks.—This species can only be compared with *D. illustrans*, from which it differs in the more robust proportions of the trunk, and the greater extent of the dorsal and anal fins.

(iii)—Caudal fin diphyccercal.

Family.—BELONORHYNCHIDÆ.

Fam. Char.—Body long and slender; snout much elongated and pointed; notochord persistent, the bases of the arches expanded; paired fins moderately developed; dorsal and anal fins large, nearly equal, and opposite, very remote; caudal fin distinct, symmetrical, fan-shaped; fulcra minute or absent. No continuous squamation, but sometimes, at least, isolated longitudinal series of dermal scutes.

Obs.—The typical genus of this family (*Belonorhynchus*) has hitherto been compared with the Ganoid *Belonostomus** and the Teleostean *Belone* and *Fistularia*,† while Lütken‡ and Zittel§ have ventured to assign it a place in the peculiar Cretaceous family of Hoplopleuridæ. The Hawkesbury fossils described below, however, demonstrate that all these conclusions are founded upon imperfect evidence; and the fish truly occupies a much lower position in the zoological scale than at present supposed.

Particularly noteworthy, for example, are the dorsal and anal fins, in which the interspinous bones are much fewer in number than the dermal rays they support (Pl. IX, Figs. 3, 4; Pl. X, Fig. 2)—a primitive character never retained in such specialized groups as the “Lepidosteoidei” and the Teleostei. Appearances are also suggestive of the presence of a series of cartilages at the base of the pelvic fins (Pl. IX, Fig. 3; Pl. X, Fig. 4), though the point is not actually proved; and one example of *B. striolatus* in the British Museum (P. 966) exhibits a pair of triangular bones in front

* H. G. Bronn, “Beiträge zur triassischen Fauna und Flora der bituminösen Schiefer von Raibl,” Neues Jahrb., 1858, p. 12. Also Smith Woodward, “Note on the Early Mesozoic Ganoid, *Belonorhynchus*,” Ann. Mag. Nat. Hist., 1888, [6] Vol. i, p. 356.

† R. Kner, “Die Fische der bituminösen Schiefer von Raibl in Kärnten,” Sitzungsber. math.-naturw. Cl. k. Akad. Wiss., Vol. liii, Pt. i, 1866, pp. 189–196, Pl. vi.

‡ O. F. Lütken, “Professor Kner’s Classification of the Ganoids,” Geol. Mag., 1868, Vol. v, p. 432.

§ K. A. von Zittel, Handbuch der Paläontologie, 1888, Vol. iii, p. 265.

of the pectoral fins, which may possibly be interpreted as infraclaviculars. Moreover, there is not the slightest trace of ossification in the sheath of the notochord; and Prof. Cope regards this character in Ganoids as a mark of very low degree.*

It is also generally admitted that the Triassic and Rhætic *Saurichthys* is closely related to *Belonorhynchus*, being referable to the same family. Such being the case, the recent discovery of the maxilla of *Saurichthys* makes known another singular feature, hitherto only observed in one of the Crossopterygian Ganoids (*Polypterus*), i.e., the presence of a considerable maxillary palatal extension.†

Genus—BELONORHYNCHUS, *Bronn*, 1858.

(Neues Jahrbuch, 1858, p. 7.)

Ichthyorhynchus, C. Bellotti, in C. Stoppani, *Studii Geol. e Pal. Lombardia*, 1857, p. 436.

Gen. Char.—Upper and lower jaws approximately equal in length, provided with few large conical teeth, and a close series of similar but smaller teeth; mandible very deep posteriorly. Head and opercular bones superficially ornamented with striations. Trunk with four longitudinal series of dermal scutes, one dorsal and another ventral, and one smaller pair laterally placed, supporting the "lateral line."

BELONORHYNCHUS GIGAS, *sp. nov.*

Pl. IX, Figs. 1, 2; Pl. X, Figs. 1, 2.

Obs.—Seven specimens, in various states of preservation, exhibit all the most characteristic features of a large species of *Belonorhynchus* attaining a length of at least 0·49, and probably sometimes much more. The series comprises :—

- (a) A nearly complete fish with imperfect fins, the pectorals being absent, the anal much broken, and the dorsal destroyed. This is the type-specimen and is shown of six-sevenths the natural size in Pl. IX, Fig. 1.
- (b) Imperfect skull and mandible (Pl. X, Fig. 1).
- (c) A smaller fragment of skull and mandible.

* E. D. Cope, *Review in Amer. Naturalist*, 1887, p. 1018.

† Smith Woodward, "On a Maxilla of *Saurichthys* from the Rhætic of Aust Cliff, near Bristol," *Ann. Mag. Nat. Hist.*, 1889, [6] Vol. iii, pp. 301, 302, Pl. xiv, figs. 7, 8.

- (d) The greater portion of the trunk in a good state of preservation (Pl. IX, Fig. 2), with the dorsal, anal, and right pelvic fins, but with an imperfect caudal.
- (e) Fragment of the middle portion of the trunk, with the left pelvic fin.
- (f) Portion of a very large trunk, probably of this species, showing the dorsal and anal fins (Pl. X, Fig. 2).
- (g) Imperfect caudal fin, showing articulated rays (Pl. VIII, Fig. 6).

General Form.—Though not exhibiting many details, the type-specimen (Pl. IX, Fig. 1), shows the general proportions of the fish; and the characters of some of the imperfect parts are displayed in other examples. The entire head, including the opercular bones, is about half as long as the trunk; and the body does not taper until the commencement of the dorsal and anal fins, in some cases, indeed, having the appearance of deepening a little at the latter point. The caudal pedicle is very narrow and short, tapering, and fringed with the caudal fin in the usual manner. The absence of the pectoral fins in the type-specimen suggests that they were small and delicate; and the pelvic fins are moderately powerful, and situated nearer to the anal than to the pectorals.

Head and Opercular Bones.—As shown both in the type-specimen and in No. b (Pl. X, Fig. 1), the skull rapidly tapers in front of the orbit, and is prolonged into a very slender snout; the alveolar border is nearly straight; and the orbit and nasal opening, though not distinctly shown, are doubtless similar in form, situation, and proportions to the corresponding apertures in the European species of *Belonorhynchus*. The mandible apparently equals the skull in depth, and, when crushed, is nearly similar to it in profile-outline. Both skull and mandible are externally ornamented by delicate ridges or striations, those upon the cranial roof being somewhat irregular and confused, but those along the sides of the skull becoming parallel, vertically directed, and passing into transverse markings upon the snout; those upon the hinder portion of the mandible (No. c) exhibit a tendency towards an irregular pattern.

The dentition (Pl. X, Fig. 1), is very powerful and apparently similar in both jaws. A widely-spaced series of very large conical teeth, with delicate superficial striations, is placed above and below, at least in the anterior half of the mouth; and between these teeth are several smaller cones attaining

only about one-half their height, but otherwise of a very similar character. It is also probable that outside this dentition, a row of very small teeth occupies the extreme margin; for in No. *c* such a series is to be seen, and its components are too small to be considered equivalent to the lesser teeth of No. *b*. All the teeth are destitute of complete sockets, and are anchylosed to the bone.

The opercular bones are not distinctly shown, but in the type-specimen there are indications of an operculum corresponding in shape and size to that of the typical *B. striolatus* from Raibl.

Axial Skeleton of Trunk.—In every example of the trunk, there is a well-marked vacant space between the opposed series of neural and hæmal arches; and it may, therefore, be inferred that the notochord was persistent. In some cases, moreover, as in the originals of Pl. IX, Figs. 1, 2, the space between the two sets of arches has been much increased by crushing—a circumstance suggestive of the same conclusion. In the type-specimen the respective lengths of the abdominal and caudal regions are about 0.18 and 0.145; and the pelvic fins are placed nearly at the hindmost extremity of the former. In both regions, the neural arches (Pl. X, Fig. 2, *n*) are all expanded, and each neural spine is broad at its base, gradually tapering to a pointed distal extremity. In the caudal region, the hæmal arches and spines (Pl. X, Fig. 2, *h*) are also similar to these, and exhibit complete symmetry with those neurals opposed to them. In the abdominal region, a series of robust, nearly straight ribs is conspicuous, giving to imperfect specimens the false appearance of a covering of deep lateral scales, like those characterizing the genus *Belonostomus*. The type-specimen (Pl. IX, Fig. 1) exhibits the ribs of the left side to the number of at least nineteen, and it is not improbable that these were succeeded by others too little ossified to be preserved. Each rib is expanded at its proximal extremity, the successive expansions doubtlessly being more or less connected one with another; and this affords an explanation of their regular linear arrangement even when displaced.

Appendicular Skeleton.—The paired fins have already been referred to—the pectorals as probably small and delicate, the pelvics as being of considerable size and placed near the hinder extremity of the abdominal region. The latter are also remarkable for the length of their base-line. There is no trace of the basal (“pelvic”) bone, but the fin-rays are at least sixteen in number (Pl. IX, Fig. 2), and each is comparatively broad and

flattened. The few most preaxial rays rapidly lengthen to the longest, those behind gradually shortening; and although each is divided by a few distant transverse joints, there is apparently no distal bifurcation.

Of the median fins, the dorsal and anal are well shown in the original of Pl. IX, Fig. 2, and also in the large specimen No. *f* (Pl. X, Figs. 2, *a*, and *d*). In the first-mentioned fossil, each fin is nearly equal in maximum depth to the breadth of the trunk at the commencement of its insertion; and the anterior margin gradually slopes backwards to the summit of the fin, whence the height diminishes behind, finally ending abruptly with the small terminal ray. Both fins are supported by a series of robust interspinous bones, much fewer than the fin-rays; and three or four of these endoskeletal elements appear to be free in advance of the dermal structures (Pl. P, Fig. 2, *in*). All the interspinous bones, as well as the neural and hæmal arches are only superficially ossified, and the soft internal cartilage is sometimes replaced by calcite, while in other cases there is no infilling, and the part has consequently become crushed or split. The fin-rays are slightly more than fifty in number in the dorsal fin, and at least fifty in the anal; they are broad and flattened, longitudinally ribbed, and closely placed proximally, though slightly diverging distally; and all are divided by several widely-spaced transverse joints, though only the hinder rays tend to branch towards the extremities. The anterior margin of both these fins and the caudal is formed by the pointed extremities of the successively lengthening rays; and there are no traces of fulcra, except in the dorsal of No. *f* (Pl. X, Figs. 2, *d*), where some minute points may perhaps be interpreted as such. The caudal fin-rays are articulated and bifurcate distally (Pl. VIII, Fig. 6), and the fin is either very slightly excavated in the middle or not forked (Pl. IX, Fig. 1).

Exoskeleton of Trunk.—The four longitudinal series of dermal scutes characteristic of the genus *Belonorhynchus*, are especially well shown in the original of Pl. IX, Fig. 2. The scutes of the median dorsal and ventral series are approximately of the same size, and relatively the largest upon the caudal pedicle; but those of the lateral line are very much smaller, being only about one-half the dimensions. The dorsal and ventral scutes are at least twice as broad as long, and bi-laterally symmetrical; and the anterior margin exhibits a wide re-entering angle, while the posterior margin has a corresponding \angle -shaped projection, thus rendering the two borders almost parallel. The lateral borders of each scute are straight, and also parallel or slightly diverging posteriorly; and the external surface is marked by a prominent tubercular

ornamentation, in addition to an occasional slight median longitudinal keel. The scutes of the lateral line, though of smaller size, appear to be of a very similar form, only differing in their more keeled character, due to the presence of the longitudinal perforation; and the latter is well shown in the fossil by the infiltration of a conspicuous white thread of calcite.

Remarks.—*B. gigas* may be distinguished from all known species of the genus by the relative breadth of the dorsal and ventral scutes. In size, it is almost equalled by *B. acutus** and *B. macrocephalus*,† and in the relative proportions of the head and trunk it is closely paralleled by the latter species; but *B. acutus* possesses spine-shaped dorsal scutes (Pl. VIII, Fig. 7), and in *B. macrocephalus* these defences are not much broader.

It is interesting to add that evidence of a still larger species of *Belonorhynchus* occurs in the Keuper of Seefeld, Tyrol, a crushed skull (as pointed out by Zittel‡) being described by Kner§ under the name of *Teleosaurus tenuistriatus*.

BELONORHYNCHUS GRACILIS, *sp. nov.*

Pl. VIII, Fig. 5; Pl. IX, Figs. 3, 4; Pl. X, Figs. 3, 4.

Obs.—A second species of *Belonorhynchus* is indicated by a fish of much more slender and delicate proportions than *B. gigas*, and usually smaller. Its character can be very completely ascertained from the following series of specimens:—

- (a) A nearly complete head and trunk, seen from the ventral aspect, wanting all the fins except portions of the anal and caudal. This is the type-specimen shown of the natural size in Pl. VIII, Fig. 5.
- (b) Detached head, side view (Pl. X, Fig. 3).
- (c) The greater portion of the trunk, side view, with imperfect pelvic and median fins.
- (d) The greater portion of the trunk, side view (Pl. IX, Fig. 3).
- (e) Hinder portion of the trunk, showing fins (Pl. IX, Fig. 4).

* *Belonostomus acutus*, L. Agassiz, Rech. Poiss. Foss., 1843, Vol. ii, Pt. ii p. 142, Pl. xlvii a, figs. 3, 4. Assigned to *Belonorhynchus* by K. A. von Zittel, Handbuch Paläontologie, Vol. iii, p. 222.

† W. Deecke, "Fische aus den schwarzen Schiefer von Perledo," Paläontographica, 1889, Vol. xxxv, pp. 127-131, Pl. viii, figs. 1, 2.

‡ K. A. von Zittel, Handbuch Paläontologie, Vol. iii, p. 266.

§ R. Kner, "Nachtrag zur fossilen Fauna der Asphaltschiefer von Seefeld in Tirol," Sitzungsab. math.-natur. Cl. k. Akad. Wiss., 1867, Vol. lvi, Pt. i, pp. 905-909, Pl. iii.

- (f) Portion of the trunk, exhibiting both pelvic fins and a fragment of the pectoral, preserved in counterpart.
- (g) Portion of the trunk, with a fragment of the left pelvic fin, and the bases of the dorsal and anal.
- (h) Fragment of large trunk, with pelvic fin (Pl. X, Fig. 4).

General Form.—As shown by the type-specimen (Pl. VIII, Fig. 5), the trunk is very long and slender, its length being at least three times as great as the total length of the head and opercular bones. As in *B. gigas* there is sometimes an indication of a slight deepening of the trunk at the commencement of the dorsal and anal fins, though this, again, may perhaps be due to crushing during fossilization. As in *B. gigas*, also, the pectoral fins appear to have been small and delicate.

Head and Opercular Bones.—The head is shown from beneath in Pl. VIII, Fig. 5, and from the lateral aspect in Pl. X, Fig. 3. The side of the skull is superficially ornamented by fine vertically directed ridges or striations, like those of *B. striolatus* and *B. gigas*; and the mandible is also marked by similar striations, curved upwards behind, but mainly extending in the direction of its long axis. Nothing noteworthy can be observed in the characters of the skull or opercular apparatus; but in the type-specimen the mandible is fractured in such a manner as to suggest the presence of an elongated anterior azygous element (Pl. VIII, Fig. 5, *ps.*), similar to that already supposed to be a presymphysial bone in the *B. acutus* of the English Lias.* The teeth are imperfectly displayed, and exhibit the usual characteristics.

Axial Skeleton of Trunk.—In every respect the known specimens of *B. gracilis* agree with those of *B. gigas* already described, in demonstrating the persistence of the notochord and the expansion of the bases of the neural and hæmal arches. These fossils, moreover, correspond in showing that the endoskeletal parts were only superficially calcified or ossified; and in some cases the crushing during fossilization seems to have produced a false appearance of striation upon the matrix where the obscure remains occur. Strong ribs are seen in the type-specimen (Pl. VIII, Fig. 5, *r*), arranged in about twenty pairs.

* Smith Woodward, "On the Mandible of *Belonostomus cinctus*," Quart. Journ. Geol. Soc., 1888, Vol. xliv, p. 147, Pl. vii, fig. 14.

Appendicular Skeleton.—Of the paired fins, the pelvics appear to have been the most powerful, and the pectorals are only represented in one specimen (No. *f*) by an imperfect fragment. As shown by No. *c*, each pelvic fin consists of at least twenty stiff rays, articulated at distant intervals; and, if this specimen is not deceptive, the appendage has a gently rounded free margin, the rays gradually diminishing in length both in front and behind (Pl. IX, Fig. 3, and Pl. X, Fig. 4). It is also, perhaps, noteworthy that in the originals of Pl. IX, Fig. 3, and Pl. X, Fig. 4, there is a considerable vacant space between the base of the dermal rays and the trunk.

The median fins are rarely well preserved, but, so far as known, they differ little in form and proportions from those of *B. gigas*. The large inter-spinous bones supporting the dorsal and anal fins are well shown in the originals of Pl. IX, Figs. 3 and 4, where they, perhaps, correspond in number with the neural and hæmal spines, but are much fewer than the fin-rays; the latter are at least fifty in number in the dorsal fin, and they are all much flattened, apparently articulated though not branching, and closely arranged.

Exoskeleton of Trunk.—Like the other species of the genus, *B. gracilis* possesses four longitudinal series of dermal scutes—a median dorsal and a median ventral of equal size, and a row of smaller scutes on each side supporting the canal of the lateral line. Each of the dorsal and ventral scutes (Pl. VIII, Figs. 5, *d.s.*, *v.s.*; Pl. IX, Figs. 3 and 4; Pl. X, Fig. 4) is longer than broad, the anterior margin having a deep triangular excavation, and the posterior margin being acutely pointed, though somewhat rounded laterally. The anterior border of one scute is overlapped, as usual, by the posterior border of the one immediately in front; and the external surface of each evidently exhibits a low longitudinal keel, though traces of superficial tuberculations are only discernible in one specimen, No. *g*. It is also interesting to observe that in one fossil (Pl. X, Fig. 4) there is an appearance of bifurcation of the ventral series of scutes in the region of the pelvic fins, resembling the loop-arrangement surrounding the “anal-grube” in *B. striolatus* (Pl. X, Fig. 5) already made known by Kner.*

Remarks.—This species is distinguished from its nearest known allies, *B. gigas* and *B. macrocephalus*, by the form of the scutes and the relatively greater elongation of the trunk.

* R. Kner, Sitzungsab. math.-natur. Cl. k. Akad. Wiss., 1866, Vol. liii, Pt. i, p. 194, Pl. vi, fig. *f*. The present Writer has been able to confirm this determination by an examination of the original specimens in the Geol. Reichsanstalt at Vienna.

B. Ganoids, in which the dorsal and hæmal interspinous bones are equal in number to the opposed dermal fin-rays.

Family—SEMIONOTIDÆ.

Fam. Char.—Body fusiform or deep, with enamelled rhombic scales; head with well-developed membrane-bones, externally enamelled; mouth small, and teeth conical or styliform. Upper lobe of tail very slightly produced. Fin-fulcra usually prominent.

Genus—SEMIONOTUS, *Agassiz*, 1843.

Semionotus, Agassiz, Rech. Poiss. Foss., 1843, Vol. ii, Pt. i, p. 222.

Ischypterus, Egerton, Quart. Journ. Geol. Soc., 1847, Vol. iii, 1847, p. 277.

Gen. Char.—Body elegantly fusiform; scales of the flank not more than twice as deep as broad, those of the ventral aspect equilateral or broader than deep; dorsal ridge-scales present, but no ventral series. Teeth small, conical, and somewhat spaced. Paired fins moderately developed; dorsal fin very large, arising near the middle of the back and partly opposed to the small anal; caudal fin large, scarcely forked. Fulcra prominent upon all the fins.

Obs.—The scientific definition of this genus has only become precise through the gradual progress of research since Agassiz's original description. For, as pointed out by Prof. Oscar Fraas,* the type-species, *S. leptcephalus*, does not pertain to the same genus as the best preserved of the other specimens described under the name of *Semionotus*; and it appears certain that the original example of the species just mentioned belongs to the genus *Pholidophorus*.† The second Agassizian species, *S. Bergeri*, is thus commonly regarded as the type; and the American Triassic fishes, named *Ischypterus* by Egerton, only differ from this form in the slightly greater development of the fin-fulcra—a feature of not more than specific value.

The genus is essentially characteristic of early Mesozoic times—notably of the Trias and Rhætic; and most of the species assigned to *Semionotus* from the Lias and later deposits are erroneously determined.

* O. Fraas, "Ueber *Semionotus*," Württ. Jahresh., 1861, Vol. xvii, p. 85.

† Smith Woodward, "Vertebrate Palæontology in some Continental Museums," Geol. Mag. [3] 1888, Vol. v, p. 401.

SEMIONOTUS AUSTRALIS, *sp. nov.*

Pl. VI, Fig. 2.

Obs.—A single imperfect specimen, wanting the head and anterior portion of the trunk, seems to pertain to a typical species of *Semionotus*, and is shown of the natural size.

General Form.—The trunk is as deep as in the most typical members of the genus, the maximum depth being probably contained not more than three-and-a-half times in the total length; and the tail exhibits the usual robust proportions. The dorsal fin is distinctly larger than the anal, though scarcely so well-developed; and this arises opposite a point immediately behind the insertion of the pelvic fins.

Appendicular Skeleton.—Of the paired fins, only the pelvics are preserved, these being small and consisting of not less than four elongated rays. The dorsal fin is evidently in part destroyed behind, but exhibits fifteen rays between its origin and a point opposite the origin of the anal; while the latter fin, so far as preserved, consists of nine well-separated rays. Fulcra are distinct upon the anterior margin of each of the fins, though relatively small and stout, except at the base of the dorsal and caudal; and all the fin-rays are of the ordinary robust, articulated, and distally-bifurcating type.

Squamation.—The scales of the anterior portion of the flank are notably deep, many being twice as deep as broad; and the lateral line was evidently well-marked, though the state of preservation of the fossil, exhibiting the lateral line of both sides, does not permit of its precise course being traced. The dorsal ridge-scales are destroyed.

Remarks.—In the form of the trunk, this species most nearly approaches *S. Bergeri*,* but is readily distinguished by the smaller fin-fulcra, the less extent of the dorsal fin, and by the depth of the principal flank-scales. In the last-named feature it also appears to differ from all other described species, except *S. Nilssoni*,† and this is characterized by a much deeper trunk.

SEMIONOTUS TENUIS, *sp. nov.*

Pl. VI, Fig. 3.

Obs.—A second well-marked species of *Semionotus* occurs in the Hawkesbury beds, as indicated by two imperfectly preserved examples, of which one is shown of the natural size.

* See especially J. Strüver, *Zeitsch. deutsch. geol. Ges.*, 1864, Vol. xvi, pp. 305-321, Pl. xiii, figs. 1, 3, 4.
 † L. Agassiz, *Réch. Poiss. Foss.*, 1843, Vol. ii, Pt. i, p. 229, Pl. xxvii a, figs. 1-5.

General Form.—The body is remarkably elongated, the maximum depth being contained more than four times in the total length. The head and opercular apparatus occupy about one-fourth of the total length; and the dorsal fin is very high, the length of the anterior ray almost equalling the depth of the trunk at its point of insertion.

Appendicular Skeleton.—The pectoral fins are placed well above the inferior margin of the flank, the remains of about six or eight rays of one fin being distinguishable in the type-specimen. The pelvic fins in each fossil are unfortunately destroyed; and only the anterior margin of the dorsal is preserved. Very little of the latter is seen in the type-specimen, but the anterior ray seems to be unbroken in the second example under discussion, and the dimensions of the fin thus indicated are shown by the dotted line (Pl. VI., Fig. 3). The anal fin is evidently opposed to the hinder portion of the dorsal, and its anterior rays are also much elongated, their length being equal to the depth of the caudal region at their point of insertion. The caudal fin is of the usual proportions, and consists of more than twenty bifurcating rays. The fulcra upon the anterior margin of each of the median fins are large and conspicuous, but remarkably slender.

Squamation.—As in *S. australis* described above, the scales of the middle of the anterior portion of the flank are twice as deep as broad; and at the extremity of the caudal pedicle, small diamond-shaped scales distinctly cover an abbreviated upper lobe.

Remarks.—This species is distinguished by the elongation of the body, the depth of the flank-scales, and the extreme tenuity of the large fin-fulcra. In the relative length and slenderness of the trunk, it is only equalled by *S. elongatus*,* from the Keuper of Stuttgart, and this species differs considerably in the characters of its squamation.

Genus PRISTISOMUS, gen. nov.

Gen. Char.—Body comparatively deep, but fusiform; three or more series of the flank-scales vertically elongated; a dorsal and ventral series of prominent ridge-scales. Teeth large, styliiform, in close series. Paired fins moderately developed; dorsal and anal fins remote, the former partly opposed to the latter; caudal fin robust, scarcely forked. Small fulcra present upon all the fins.

* O. Fraas, "Ueber *Semionotus*," Württ. Jahresh., 1861, Vol. xvii, pp. 93, 95, Pl. 1, figs. 4, 5.

Obs.—This is an interesting genus, most nearly related to *Semionotus* and *Dapedius*, and in some respects intermediate between these two forms. The long styliform teeth, and certain obscurely recognizable features in the head, are most suggestive of *Dapedius*; and the depth of the trunk nearly approaches that of some of the species of the last-named genus. The dorsal ridge-scales, however, and the proportions of the median fins, more resemble corresponding features in *Semionotus*; though this well-known genus is distinguished by its dentition, the absence of ventral ridge-scales, the slight vertical elongation of the flank-scales, and the greater development and more forward position of the dorsal fin.

In the vertical elongation of the flank-scales, *Pristisomus* may also be compared with a Liassic genus, *Nothosomus*, described by Egerton;* but in every other known feature of importance these two generic types are distinct.

PRISTISOMUS GRACILIS, *sp. nov.*

Pl. V, Fig. 1; Pl. VI, Fig. 1; Pl. VIII, Fig. 1.

Obs.—The typical species, *P. gracilis*, is so well represented by a single complete trunk, that only two other specimens need be referred to for the determination of the characters of the head, while a third exhibits the dorsal and anal fins in unusual completeness. These fossils may be enumerated thus:—

- (a) Type-specimen, shown of the natural size in Pl. V, Fig. 1.
- (b) Somewhat more slender fish, exhibiting the head, but wanting the paired fins.
- (c) An imperfect specimen, showing part of the head and opercular apparatus (Pl. VI, Fig. 1).
- (d) An imperfect specimen with well-preserved median fins (Pl. VIII, Fig. 1).

General Form.—The trunk is gracefully fusiform, the maximum depth being contained more than two-and-a-half times in the total length. The head is triangular and the snout pointed, and the distance from the extremity of the snout to the posterior margin of the operculum is not more than one-quarter of the total length. The dorsal and anal fins are almost of equal size, with a short base-line and much elevated.

* "Figs. and Descrip. Brit. Org. Remains," Mem. Geol. Survey, Gt. Brit., 1858, Dec. ix, No. 6.

Head and Opercular Apparatus.—The proportions of the head and opercular apparatus are shown in No. *b*, but the only example exhibiting the faintest details of structure is the imperfect specimen, No. *c* (Pl. VI, Fig. 1). The roof of the skull is extended by membrane bones well over the operculum; the orbit is large, and the two postero-superior elements of the well-developed sub-orbital ring are evident. The preoperculum appears to have been absent, and the operculum and suboperculum have a short antero-posterior measurement; the precise position of the suture between the two latter elements is uncertain, though it is probably the lower of the two transverse lines indicated in the figure.

Appendicular Skeleton.—Portions of the paired fins are preserved in the type-specimen (Pl. V, Fig. 1), both exhibiting much elongated slender rays; and the pelvic fins are placed much behind a point half-way between the opercular apparatus and the anal fin. As just mentioned, the dorsal and anal fins (Pl. V, Fig. 1; Pl. VIII, Fig. 1) are almost equal in size, and the former arises slightly in advance of the latter; the length of the longest rays in the anal is greater than the extent of the base-line, while in the dorsal the same is almost the case; and in the first-mentioned fin there are twelve or thirteen rays, while in the dorsal this number is only exceeded by one or two. The caudal fin is beautifully preserved and slightly forked, consisting of about sixteen to twenty rays; and its upper and lower margins, like the anterior margins of the dorsal and anal, are fringed with delicate fulcra. The fin-rays are well spaced, and in all the fins they appear to be closely articulated and soon bifurcating.

Squamation.—The scales of two series upon the middle of the anterior portion of the flank are in part four times as deep as broad, and, as shown by No. *c* (Pl. VI, Fig. 1), the lateral line traverses the uppermost of these, dividing each scale unequally in the ordinary manner. Above and below the two principal series just mentioned, the scales are much deeper than broad in two other series, and it is only towards the extremity of the caudal region that they appear to become equilateral. The sharply-pointed dorsal and ventral ridge-scales are also distinctly recognizable.

Remarks.—From the species described below, *P. gracilis* is distinguished by its more slender proportions, and the great elevation of the dorsal and anal fins.

PRISTISOMUS LATUS, sp. nov.

Pl. V, Figs. 2, 4.

Obs.—Several specimens indicate the occurrence of a comparatively deep-bodied species of *Pristisomus*, and the following three may be selected for special notice :—

- (a) The type-specimen, wanting the caudal pedicle and fin, shown of the natural size in Pl. V, Fig. 2.
- (b) A more imperfectly preserved fish, wanting the head and paired fins (Pl. V, Fig. 3).
- (c) Imperfect fish, with well-displayed pectoral fin (Pl. V, Fig. 4).

General Form.—The trunk is comparatively high, the maximum depth being contained only two and a half times, or less, in the total length. The head is triangular and the snout pointed, and the distance from the extremity of the snout to the posterior margin of the operculum is contained slightly more than four times in the total length. The dorsal fin is considerably longer than the anal and not remarkably elevated, and the caudal fin is apparently small.

Head and Opercular Apparatus.—In the type-specimen (Pl. V, Fig. 2) the dentary bone is seen to be robust, and the close array of styliiform teeth is displayed ; but no other details are recognizable, nor is any other specimen more satisfactory.

Appendicular Skeleton.—The paired fins are placed well upon the sides of the trunk ; each of the pectorals exhibiting not less than nine robust rays of considerable length (Pl. V, Fig. 4), and the pelvics being much smaller, with at least six rays in the type-specimen. The pelvic pair is placed nearer to the anal than to the insertion of the pectoral pair ; and the dorsal and anal are opposed in the ordinary manner. The dorsal fin exhibits seventeen rays in the type-specimen, and the length of the longest is much less than that of the base-line. The anal fin, which appears to be complete in No. *b* (Pl. V, Fig. 3) is more elevated than the dorsal, comprising about fourteen rays ; but its longest ray scarcely exceeds the length of its base-line. The caudal fin, if complete in No. *b* (Pl. V, Fig. 3), is relatively small, exhibiting twenty-two rays ; and the anterior margins both of this and the other median fins are provided with prominent fulcra, with a few of especially large size at the base. A few interspinous bones in the anal of No. *b* are seen to correspond in number with the opposed fin-rays.

Squamation.—The scales are best exhibited in the type-specimen (Pl. V, Fig. 2), which shows two very deep series upon the middle of the anterior portion of the flank, the vertical measurement of the deepest being a little more than three times their antero-posterior dimension. Above and below there is also another remarkably deep series; and the only scales as broad as deep are those upon the dorsal and ventral aspects of the abdomen, and upon the caudal pedicle behind the dorsal and anal fins. The dorsal and ventral ridge-scales are conspicuous.

Remarks.—This species is distinguished by the depth of the trunk, the small size of the head, and the relative length of the dorsal fin.

PRISTISOMUS CRASSUS, *sp. nov.*

Pl. V, Figs. 5-7.

Obs.—The principal characters of a very robust species with large scales are illustrated by the following specimens:—

- (a) Type-specimen, wanting the dorsal fin and the upper lobe of the tail, shown of the natural size in Pl. V, Fig. 5.
- (b) Head and incomplete trunk, partly shown of the natural size in Pl. V, Fig. 6.
- (c) Trunk, wanting the head and paired fins, the caudal region being shown of the natural size in Pl. V, Fig. 7.
- (d) Imperfect fish, showing squamation.
- (e) Imperfect large fish.

General Form.—Compared with the typical species, the trunk is elongated and robust, the greatest depth being contained about three times in the total length. The head is large, and the distance between the extremity of the snout and the posterior margin of the operculum is at least one quarter of the total length. The dorsal fin is much elevated, being as high as long; and the caudal fin is large.

Head and Opercular Apparatus.—The head in the original of Pl. V, Fig. 6, exhibits a few points of interest, and suggests that there was a certain amount of ossification in the chondrocranium, as in *Dapedius*. Membrane-bones are also well developed, the roof being protected with thick plates, and a slender bone, like the parasphenoid, lying across the orbit. The mouth is small, with closely arranged styliform teeth, two being comprised within the

space of a millimetre; and each of these teeth has a stout basal portion, becoming suddenly slender at about its middle. The bones of the opercular fold have a small antero-posterior measurement, but it is almost impossible to distinguish the limits between the different elements; the operculum, however, is probably at least twice as deep as broad, and the suboperculum half the size, as suggested by the type-specimen (Pl. V, Fig. 5).

Appendicular Skeleton.—All the fin-rays are very robust and closely articulated, and fulcra are always distinct. The paired-fins seem to be inserted close to the ventral margin; and the pelvic pair is well developed, each fin having not less than six or seven rays, and its point of insertion not being much nearer to the anal than to the insertion of the pectorals. In the original of Pl. V, Fig. 7, the dorsal fin exhibits fourteen rays, the length of the longest equalling that of the base-line as preserved; and the anal fin is much smaller, with only twelve or thirteen rays. The powerful caudal fin is slightly forked, and comprises not less than sixteen rays.

Squamation.—As usual in the genus, the scales of two series upon the middle of the flank are much vertically elongated, while the series immediately above, and two series below, are also remarkably deep. The lateral line crosses the superior third of the upper of the deepest flank-series.

Remarks.—The large size of the head and the robust proportions of *P. crassus* render even imperfect examples at once recognizable.

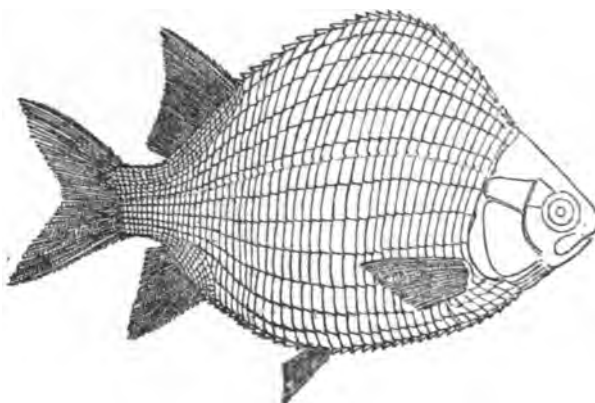
Genus—CLEITHROLEPIS, *Egerton*, 1864.

(Quart. Journ. Geol. Soc., vol. xx., p. 3.)

Gen. Char.—Head small; snout acute; trunk very deep; the dorsal and anal fins remote and opposite; dorsal margin in advance of the fin considerably arched, ventral margin in advance of the fin more gently arched; caudal pedicle short, the upper lobe scarcely produced; caudal fin slightly forked; pectoral fins large; pelvic fins present; scales deep, united by a peg-and-socket arrangement of the anterior thickened margin; the series between the dorsal and anal fins sharply turned forwards for a short space above and below; ridge-scales present both dorsally and ventrally.

Obs.—This genus was originally founded by Sir Philip Egerton (*loc. cit.*) upon an imperfect specimen discovered in the Hawkesbury rocks of Cockatoo Island, and was naturally compared with the late Palæozoic genus,

Palæoniscus, from the Permian of Europe. At first sight, the resemblance is certainly striking; and the Australian genus was originally placed in the family of Pycnodontidæ, at that time considered to include fishes of the Platysomid type. A later discovery, however, in the Stormberg beds of South Africa,* has shown that *Cleithrolepis* is nearly related to *Tetragonolepis* (an ally of *Dapedius*), differing both in the structure of the head and the tail from the Platysomidæ. As shown in the accompanying restoration of the type-



species, based upon the fossils described below, the tail is almost homocercal—certainly as much so as in the existing *Lepidosteus*; and no preoperculum can be distinguished. So far as recognizable, there is a narrow regular ring of circumorbital membrane-bones, in addition to distinct suborbitals; and it seems evident, though not absolutely proved, that each ray of the dorsal and anal fins was originally supported by a separate interspinous bone. At the same time, it may be noted that the large relative size of the suboperculum, and the small dimensions of the operculum, are unparalleled among known Dapedioids, while characteristic of Platysomids;† and the peculiar forward reflection of the scales at the base of the dorsal and anal fins is unique in the former group, though well known at least in the anal region of the type-genus of the latter. The singular elevation of the dorsal margin in advance of the dorsal fin is also most suggestive of fishes of the Platysomid family.

Notwithstanding the great number of individuals contained in the present collection, it does not appear possible to recognize with certainty more than a single species—that first described by Egerton under the name of *C. granulatus*—though one imperfect specimen may perhaps indicate a

* Smith Woodward, "On two New Lepidotoid Ganoids from the Early Mesozoic Deposits of the Orange Free State, South Africa," *Quart. Journ. Geol. Soc.*, Vol. xlv, pp. 141-143, Pl. vi, figs. 6, 7.

† See R. H. Traquair, "On the Structure and Affinities of the Platysomids," *Trans. Roy. Soc. Edinb.*, 1879, Vol. xxix, pp. 348-391, Pls. iii-vi.

second form. Only one other member of the genus has yet been definitely determined, namely, *C. Extoni*, from the Stormberg beds of Rouxville, Orange Free State, South Africa;* and although it is not impossible that fragments of close allies are already known, both from the Trias of India,† and the Keuper of England,‡ further discoveries must be awaited before any definite statement can be formulated.

CLEITHROLEPIS GRANULATUS, Egerton.

Plate VII; Plate VIII, Figs. 2, 3.

Cleithrolepis granulatus, Egerton, Quart. Journ. Geol. Soc., 1864, vol. xx, p. 3, pl. i, figs. 2, 3.

Obs.—Of the numerous examples of this species, the following may be selected as illustrating its main structural features, so far as they are distinguishable :—

- (a) Small fish, wanting the pelvic fins (Pl. VII; Fig. 1).
- (b) A small slab of rock, in counterpart, displaying two imperfect individuals of larger size, one being shown in Pl. VII, Fig. 2, and the head of the other in Pl. VII, Fig. 3.
- (c) Complete trunk, with parts of the head and fins, a portion of the abdominal region shown in Pl. VII., Fig. 4.
- (d) Large specimen, showing the position of the pelvic fins and well-preserved median fins (Pl. VII, Fig. 5).
- (e) Two associated fragmentary fishes, one exhibiting the squamation between the dorsal and anal fins (Pl. VIII, Fig. 3).
- (f) Specimen showing the position and proportions of the pelvic fins (Pl. VIII, Fig. 2).
- (g) Two associated imperfect fishes, one showing the dorsal serrations (Pl. VII., Fig 7).
- (h) Imperfect fish, exhibiting a few details of the squamation, six scales of the anterior portion of the lateral line being shown of the natural size in Pl. VII, Fig 6.
- (i) Large imperfectly preserved fish, 0·11 in length from the posterior edge of the clavicle to the extremity of the caudal pedicle.

* Smith Woodward, *loc. cit.*

† *Tetragonolepis analis*, Egerton, Pal. Indica, 1878, Ser. 4, Vol. i, Pt. 2 p. 5, Pl. iii, fig 1.

‡ *Dipteronotus cyphus*, Egerton, Quart. Journ. Geol. Soc., 1864, Vol. x, pp. 369-371, Pl. xi.

General Form.—Though a fish of the form of that now under discussion is naturally much distorted, in most cases, when buried in sediment, the study of a large series of specimens seems to reveal approximately its normal proportions. The original of Pl. VII, Fig. 1, may perhaps be taken as a typical example to exhibit the form of the trunk, while the original of Pl. VII, Fig. 5, determines the proportions of the caudal pedicle and fin. The head occupies a little more than one-fifth of the total length of the body (exclusive of the caudal fin), and its height at the anterior margin of the operculum is contained slightly more than two-and-a-half times in the maximum depth of the trunk. The dorsal fin arises at the commencement of the posterior third of the trunk; and the dorsal margin in advance of this is so much arched that, about half-way between the fin and the head, the maximum depth of the trunk equals its extreme length from the back of the clavicle to the base of the caudal fin. The pectoral fins are very large, and the pelvic fins are placed about half-way between the head and the anal fin, while the ventral margin immediately in advance of the latter perceptibly bulges downwards. The caudal fin is relatively large and powerful.

Head and Opercular Apparatus.—The opercular bones and the external elements of the head, Pl. VII, Fig. 3, exhibit a granular ornamentation, but little can be discovered of details. The orbit is well marked, being surrounded by superficial membrane bones, forming apparently a narrow circumorbital ring, bordered postero-inferiorly by large suborbitals (*so.*) between which the sutures are usually indistinct. The membrane-bones of the cranial roof are continued backwards by a large plate extending prominently above the operculum; and between it and the latter element there is sometimes a space that may have been occupied by a chain of bones, such as has been supposed to occur in *C. Extoni*.^{*} The operculum (*op.*) is only half as large as the suboperculum (*s. op.*), and almost triangular in shape, owing to the absence of the postero-superior angle; the sub-operculum equals the operculum in width, but is twice as deep; and beneath the last-named bone there are three or four stout branchiostegal rays (*br.*) sometimes distinctly observable. The preoperculum was presumably absent, there being scarcely space for it in its ordinary situation; and no traces of an interoperculum can be recognized.

Appendicular Skeleton.—Several specimens exhibit portions of a long slender clavicle (Pl. VII, Fig. 3, *d*) and a supraclavicle; but none of the

^{*} Smith Woodward, *loc. cit.*, p. 141, Pl. vi, fig. 7.

bones of the pectoral arch are sufficiently displaced and exposed for precise description. The pectoral fin is very large, and placed upon the side of the trunk slightly below the level of the lower margin of the suboperculum. In the original of Pl. VII, Fig. 1, not less than twelve or thirteen rays can be counted, spreading distally, and being at least equal to the head in length. The pelvic fins (Pl. VIII, Fig. 2) were evidently smaller, though well developed for a fish of this type.

Of the median fins (Pl. VII, Fig. 5), the dorsal is longer than the anal, but relatively less elevated; and the posterior points of termination of these fins seem to correspond, the anal thus arising further back than the dorsal. In each fin, the rays gradually diminish in length backwards, and are most widely spaced posteriorly; they are about seventeen in number in the dorsal, and not more than twelve in the anal. Both in these fins and in the caudal, the rays are stout, exhibit numerous articulations, and begin to bifurcate at a considerable distance from the distal extremity, and the fulcra upon the anterior margin are prominent. The caudal fin is well shown in Pl. VII, Fig. 5, being very large and powerful, consisting of twenty-four to twenty-six rays, widely spread, and slightly forked; at its base also are a few large fulcral scales, both above and below.

Squamation.—Though individual scales are rarely distinguishable, the general characters of the squamation can be well determined. Sir Philip Egerton has already pointed out that the scales are deep, superficially granulated, and united together by a peg-and-socket arrangement of the anterior thickened margin. It is now possible to add some interesting information concerning their variation and disposition. The lateral line is prominently marked in specimens sufficiently well preserved (not in Pl. VII, Figs. 1 and 2), by its perforation of a horizontal series of scales almost along the middle line of the flank; and in one specimen (No. *h*) these scales towards the posterior part of the abdominal region are seen to be five or six times as deep as broad, with the perforation marking the lower limit of the superior third or slightly above the middle point (Pl. VII, Fig. 6). The scales above and below this series are also much deeper than broad, except near the dorsal and ventral margin; and upon the caudal region, at the point of origin of the dorsal fin, the vertical series of scales are rapidly narrowed, though in some specimens this feature is evidently emphasised by distortion during fossilization. Moreover, to a depth of about 0.005 from the base both on the dorsal and anal fins, the series of scales are distinctly displaced from their

normal direction and trend forwards (Pl. VIII, Figs 2 and 3). There is also an unconformity, so to speak, between the scales immediately beneath the pectoral fin and the ordinary series of the flank. In a triangular area behind and beneath the clavicle (Pl. VII, Fig. 4), extending along the ventral aspect to a point below the middle of the longest pectoral ray, the scales trend downwards and forwards in slight curves of which the concave aspect is anterior; and these, like the normal series behind, are terminated below by prominent ridge-scales. This ventral armature is well seen in several specimens, and evidently implies that the lower portion of the abdomen was, during life, broad, for each scale consists of a right and left half, apparently meeting at a very obtuse angle in the median line. The dorsal margin of the trunk is similarly provided with ridge-scales, but in this case much more acutely compressed from side to side. In badly preserved specimens this superior margin thus appears curiously serrated (Pl. VII, Fig. 7), and there is sometimes a deceptive series of forwardly directed denticulations; but when the scales are distinguishable, those of the ridge are seen to correspond in number with the normal series of the flank, none being crenulated, and each giving rise to only one backwardly-turned point.

Remarks.—So far as known, the South African species, *C. Extoni*, seems to be very closely related to the type-species thus described. It agrees well in the form and proportions of the trunk, and it may be that the differences in the proportions of the fins are due to imperfect preservation. In the dorsal and anal fins of *C. Extoni*, however, a number of the anterior rays are much more closely arranged in comparison with those that follow than is the case in *C. granulatus*.

CLEITHROLEPIS [? ALTUS, *sp. nov.*]

Plate VIII, Fig. 4.

Obs.—As already mentioned, a single specimen in the collection is referable to a form of *Cleithrolepis* with a deeper trunk than that of the normal *C. granulatus*. This fossil is shown of the natural size in Pl. VIII, Fig. 4; and, apart from its shape, it is also interesting as exhibiting feeble impressions of the scales, which have been carefully traced by Mr. Percy Highley, and somewhat emphasised in the drawing.

The arched dorsal margin of the trunk in this unique specimen is much more angulated than usual, and the maximum depth (0.098) exceeds the distance from the posterior margin of the operculum to the end of the

caudal pedicle probably by not less than one centimetre. The lateral line proceeds from the level of the upper margin of the operculum, and is gradually arched, assuming a mesial position upon the flank between the dorsal and anal fins. It crosses the superior half of a vertically-elongated series of scales, nearly six times as deep as broad anteriorly; and both above and below this there are other series of considerable depth. The dorsal ridge-scales in advance of the "apex" of the trunk (Pl. VIII, Fig. 4a) are twice as broad as many of those behind; and the former display the characteristic superficial granulation.

Family—PHOLIDOPHORIDÆ.

Fam. Char.—Body elongated or fusiform, with enamelled rhombic scales; head with well developed membrane bones, externally enamelled; gape wide, and teeth conical, usually small; snout not produced. Upper lobe of tail externally inconspicuously or very slightly produced. Fin-fulcra minute.

Genus—PHOLIDOPHORUS, *Agassiz*, 1843.

(Rech. Poiss. Foss., vol. ii, pt. i, p. 271).

Gen. Char.—Body fusiform, usually elongated; tail externally homocercal, caudal fin forked; snout obtuse; teeth minute; dorsal fin short, but moderately developed, larger than the anal, and arising above or shortly behind the pelvic fins; pectoral fins small or moderately developed. Scales deeper than broad upon the flank; no continuous series of ridge-scales, but one, two, or three large plates usually present in advance of the median fins.

Obs.—As remarked, especially by Zittel,* several extraneous species were originally referred to this genus, and its limits have thus been somewhat unscientifically extended. Only a single character, however, that might possibly be deemed of generic value, separates one form of Hawkesbury fish from the typical species, *P. Bechei*,† namely, the origin of the dorsal fin posterior to a point opposite the pelvic pair, thus rendering it partly opposed to the anal. This character alone does not appear sufficient for the erection of a distinct genus; and we therefore venture to record the occurrence of a new species of *Pholidophorus* in New South Wales, more especially as Mr. William Davies‡ has lately ascribed to this genus a Purbeckian fish having its dorsal fin in precisely the same remote situation.

* K. A. von Zittel, Handbuch der Paläontologie, 1887, Vol. iii, pp. 214–216.

† L. Agassiz, Rech. Poiss. Foss., 1843, Vol. ii, pt. i, p. 272, Pl. xxxix, figs. 1–4.

‡ W. Davies, "On a New Species of *Pholidophorus* from the Purbeck Beds of Dorsetshire," Geol. Mag., 1887, [3] Vol. iv, p. 338, Pl. x, fig. 1 (*P. brevis*).

PHOLIDOPHORUS GREGARIUS, *sp. nov.*

Plate VI, Figs. 6-10.

Obs.—The small fishes of this species are among the commonest of the Hawkesbury fossils, and seemed to have lived and died in considerable shoals. About seven specimens may be selected to elucidate all the main points in their structure, except the osteology of the skull, of which little can be discerned.

- (a) The type-specimen, the trunk being preserved in counterpart. This is shown of twice the natural size in Pl. VI, Fig. 6, and is associated on the same slab with two smaller examples.
- (b) A more incomplete smaller specimen, shown of twice the natural size in Pl. VI, Fig. 7.
- (c) A still smaller, more elongated fish, shown of twice the natural size in Pl. VI, Fig. 8.
- (d) Head and anterior portion of trunk.
- (e) Imperfect head and anterior portion of trunk, the head being shown of twice the natural size in Pl. VI, Fig. 10.
- (f) A small elongated fish, wanting the fins; the head shown of twice the natural size in Pl. VI, Fig. 9.
- (g) Four associated small fishes upon one slab, with a small *Dictyopyge*.

General Form.—As shown by the figures, there is considerable variation in the proportions of the individuals assigned to this species; but it does not appear possible to discover any characters by which they can be further separated. The original of Fig. 8 is much smaller and more elongate than the type, but is partly connected with it by No. *b* (Fig. 7); and in two instances these forms are associated upon one slab of rock, as if they formed part of the same shoal. It may also be noted that in the original of Fig. 8 the dorsal and anal fins are depressed, while there are signs of post-mortem compression; and an individual equally slender, upon the slab No. *g*, exhibits the tail as widely spread as that of the type. The head, with the opercular apparatus, does not occupy more than about one-fifth of the total length of the fish; the fin-rays are robust, and, in the median fins, spaced considerably apart; and the dorsal fin is large, arising opposite the space between the pelvic pair and the anal, and partly opposed to the latter.

Head and Opercular Apparatus.—The head is short and rounded, and the snout not produced to a point. The orbit is large, the mouth of moderate size, and the lower jaw stout. As usual, the exposed surfaces of the bones are mostly destroyed, but there are indications of an ornament consisting both of small tubercles and striæ. Of the cranial roof-bones, only the frontals are displayed in impression (Pl. VI, Fig. 9), and these are very suggestive of the corresponding elements of the European *Pholidophorus*.^{*} For nearly half of their extent posteriorly they are relatively broad, but the outer lateral margin of each rapidly curves inwards in front, and the anterior third of the bone becomes narrow. Unless appearances in No. *d* are deceptive, the maxilla is long and gently curved, exactly as in the typical *Pholidophorus*; and it also bears a series of minute, conical, pointed teeth. In the mandible, the dentary bone is large and broad, but its dentition is not clearly distinguishable. The post-orbital bones are large, at least two being well shown in No. *e* (Pl. VI, Fig. 10); and the upper of these is quadrangular, about as long as deep, while the antero-inferior angle of the lower is so much produced forwards as to make it appear almost triangular. There is also a mark round the eye in this fossil, which may be either a narrow, regular, circumorbital ring, or merely an ossified sclerotic capsule. The opercular bones are narrow, but the divisional line between the operculum and sub-operculum is not very distinct; this appears, however, to be oblique, and would thus correspond with that of the typical *Pholidophorus*.

Axial Skeleton of Trunk.—There is distinct evidence of the persistence of the notochord, and this is but very slightly produced upwards at its hinder extremity to form a superior caudal lobe. The neural and hæmal arches must also have been imperfectly ossified, for nothing can be discerned as to their form and proportions, even where the scales are removed.

Appendicular Skeleton.—In the pectoral arch the clavicle is slender, and longitudinally striated, at least in its lower portion; and the type-specimen (Pl. VI, Fig. 6) exhibits indications of two of the large post-clavicular scales. The pectoral fins are moderately powerful, each consisting of about eight or nine rays, the first four or five especially stout, and the remainder more delicate and closely arranged (Pl. VI, Fig. 6). The pelvic fins are small, each consisting probably of not more than five or six rays;

^{*} L. Agassiz, *Tome cit.*, Pt. i, p. 286, Pl. xlii a, fig. 5 (*Pholidophorus minor*).

and they are placed about half-way between the pectorals and the anal, though generally nearest to the latter.

The median fins are large and powerful, all consisting of a few strong, widely-spaced rays, articulated and bifurcated distally. In front of each there are three or four small polished rays, to be regarded as representing fulcra; and in the dorsal and anal fins the number of supporting inter-spinous bones exactly corresponds to that of the ordinary rays. The dorsal fin is larger than the anal, the one comprising not less than twelve rays and the other only about eight; and the latter commences at a point opposite the middle of the former. The caudal fin has the appearance of being somewhat excavated, but it was probably not deeply forked. The upper lobe of the caudal pedicle is atrophied, and the number of rays is about fourteen.

Squamation.—The large rhombic scales with which the fish is covered appear to have been originally thick and enamelled, but they are generally much abraded, and both dorsally and ventrally upon the caudal region they are nearly always destroyed. None exhibit any traces of serrations upon the posterior margin. Those of the flanks are best shown in No. 6 (Pl. VI, Fig. 7), and as far back as the origin of the anal fin at least, four horizontal series are much deeper than long. The scales of the lateral line are deepest, and the "line" itself crosses each of these obliquely nearest its upper extremity, producing a prominent ridge. There is one series of vertically-elongated scales above the lateral line, and two can be distinguished below; and the few series placed dorsally and ventrally comprise smaller scales of more equilateral form. There are no ridge-scales, except immediately in front of the median fins. One or two large oval scales occur in front of the dorsal; there are three both on the upper and lower margin of the caudal pedicle; and a small fish on the slab with the counterpart of the type-specimen, exhibits two (or perhaps three) others in advance of the anal.

Remarks.—From all species of similar proportions *P. gregarius* is distinguished by the remote situation of the dorsal fin.

Genus—PELTOPLEURUS, Kner, 1866.

(Sitzungsab. math.-naturw. Cl. kongl. Akad. Wiss., vol. liii, pt. i, p. 180.)

Gen. Char.—Body deeply fusiform; tail externally homocercal; caudal fin forked; snout obtuse; teeth minute. Paired fins feebly

developed; dorsal and anal fins small and short, the former at least in part opposed to the latter, though usually arising in advance of this. Scales of the flank in one [or three] deep series; dorsal and ventral scales nearly equilateral; ridge-scales absent.

Obs.—This interesting genus has hitherto been discovered only in the Keuper of Raibl, Carinthia,* and of Seefeld, in the Tyrol,† and it is somewhat doubtful whether we are now justified in recording its occurrence in the Hawkesbury beds of New South Wales. In the Survey Collection, however, there is a small species, which, so far as can be determined, only differs from the typical *Peltopleurus* in the character added to the above definition in square brackets. It is perhaps contrary to analogy to permit such an extension of the genus; but, under any circumstances, the Hawkesbury fish is closely related to the European type just mentioned, and, awaiting further discoveries, it may be provisionally placed here.

PELTOPLEURUS (?) DUBIUS, *sp. nov.*

Pl. VI, Figs. 4, 5.

Obs.—From an extensive series of specimens, the following may be selected as characteristic and comparatively well preserved:—

- (a) Type-specimen, wanting the pectoral fins, shown of the natural size in Pl. VI, Fig. 4.
- (b) Imperfect fish, displaying the squamation, shown of twice the natural size in Pl. VI, Fig. 5.
- (c) A smaller fish, apparently of more slender proportions.

General Form.—Some examples of the fish are a little more elongated than others, but the differences seem to be mainly due to *post-mortem* distortion. The type-specimen probably displays the original proportions, and in this the caudal pedicle is short and slender, and the maximum depth of the abdominal region is contained about three times in the total length of the fish. The head and opercular apparatus occupy considerably less than a quarter of the total length. The dorsal fin is somewhat larger than the anal, and arises just in advance of the latter.

* *P. splendens*, R. Kner, Sitzungsab. math.-naturw. Cl. k. Akad. Wiss., 1866, Vol. liii, Pt. i, pp. 180-183, Pl. iv, fig. 3.

† *P. humilis*, R. Kner, *ibid.*, 1867, Vol. lvi, Pt. i, p. 904, Pl. 1, fig. 2.

Head and Opercular Apparatus.—There is nothing worthy of remark concerning the bones of the head, few sutures being distinguishable. The orbit is large and bordered postero-inferiorly in the usual manner with broad suborbitals; and the slender jaws seem to have been provided with minute teeth. The opercular apparatus is equal in width to the posterior suborbitals; and either the operculum or suboperculum is at least twice as deep as broad.

Appendicular Skeleton.—The paired fins seem to have been very small and delicate, for the pectorals are in every case destroyed, and only traces of the pelvic pair are observed in the type-specimen (Pl. VI, Fig. 4). The latter are placed nearer to the anal fin than to the probable insertion of the pectorals. The dorsal fin arises very slightly in advance of the anal, with eleven rays in the type-specimen; and the length of the longest anterior ray equals half the depth of the trunk at its insertion. The anal fin also exhibits ten or eleven rays, and is evidently at least as elevated as the dorsal, though with a shorter base-line. The caudal fin is not completely preserved in any specimen, but it consists of not less than sixteen rays, and was probably somewhat forked. In advance of each of the median fins there are slender basal fulcra, continued as a very minute fulcral fringe upon the anterior ray; and each of the rays is broad and divided at distant intervals by transverse joints, while there is usually a distal bifurcation.

Squamation.—The scales are best displayed in an impression shown of twice the natural size in Pl. VI, Fig. 5. The principal portion of the flank is occupied by three deep series, of which the uppermost is traversed by the lateral line (Pl. VI, Fig. 4), and above and below are two or three small series of nearly equilateral diamond-shaped scales, such as also predominate towards the end of the caudal pedicle.

Remarks.—So far as can be determined from the foregoing description, it will be observed that the Australian species only differs essentially from the typical *Peltopleurus* in the single series of deep flank-scales being represented by three series. In this respect it approaches *Pholidophorus*, and other features also are suggestive of the latter genus. The trunk, however, in the species now under consideration is deeper than is usual in *Pholidophorus*, the opercular bone already described is most nearly paralleled by the operculum of *Peltopleurus*, and there are apparently no large azygous scales in front of the median fins, such as characterize *Pholidophorus*. We therefore venture to assign the fish only a provisional generic position.

Genus non det.

Pl. VI, Figs. 11, 12.

The imperfect anterior portion of a small elongated fish is shown of the natural size in Pl. VI, Fig. 11, and a few of the scales are enlarged five times in Pl. VI, Fig. 12. The specimen, however, is too imperfect for generic determination, and it is only noticed to point out the possibility that it may indicate the occurrence in the Hawkesbury beds of the genus *Ptycholepis*, Agassiz. The gape of the mouth is evidently wide; the suspensorium is slightly oblique; and the body is covered with small, narrow scales, difficult to interpret in the impression, but probably somewhat as represented in the enlarged figure. A few rays of the pectoral fin are preserved, while the pelvic fin consists of very delicate rays, and seems to have an extended base-line. If the fossil does not represent an ally of *Ptycholepis*, it probably pertains to some fish of the type of *Dictyopyge*.

III.—CONCLUSION.

As the result of the researches detailed in the foregoing Memoir, the Fish-fauna of the Hawkesbury beds at Gosford may be tabulated as follows :—

SELACHII.

Genus non det.

DIPNOI.

Gosfordia, *gen. nov.*

„ truncata, *sp. nov.*

GANOIDEI.

PALÆONISCIDÆ.

Myriolepis, *Egerton.*

„ Clarkei, *Egerton.*

„ latus, *sp. nov.*

Apateolepis, *gen. nov.*

„ australis, *sp. nov.*

CATOPTERIDÆ.

Dictyopyge, *Egerton.*

„ symmetricus, *sp. nov.*

„ illustrans, *sp. nov.*

„ robustus, *sp. nov.*

BELONORHYNCHIDÆ.

Belonorhynchus, *Bronn.*

„ gigas, *sp. nov.*

„ gracilis, *sp. nov.*

SEMIONOTIDÆ.

Semionotus, *Agassiz.*

„ australis, *sp. nov.*

„ tenuis, *sp. nov.*

Pristisomus, *gen. nov.*

„ gracilis, *sp. nov.*

„ latus, *sp. nov.*

„ crassus, *sp. nov.*

Cleithrolepis, *Egerton.*

„ granulatus, *Egerton.*

„ (?) altus, *sp. nov.*

PHOLIDOPHORIDÆ.

Pholidophorus, *Agassiz*.,, *gregarius*, *sp. nov.*(?) *Peltopleurus*, *Kner*.,, (?) *dubius*, *sp. nov.*

An examination of this list at once demonstrates that the Fauna is of early Mesozoic age, and as only one rhombic-scaled ganoid with a semi-heterocercal tail (*Acentrophorus*¹) has hitherto been discovered below the Trias, it will suffice to institute comparisons with the known Fish-faunas of Triassic, Rhætic, and Liassic date.

Little is known of the fossil fishes of the Lower Trias (Bunter) of Europe, only two species (*Dictyopyge rhenana*, and *Semionotus alsaticus*) having been definitely determined from the valley of the Rhine.² From the Muschelkalk and Lettenkohle, however, numerous species are more or less satisfactorily described. In addition to teeth of Selachians and the Dipnoan *Ceratodus*, Agassiz³ described many fragmentary remains of Ganoids from the Continental Muschelkalk. H. von Meyer,⁴ P. Gervais,⁵ E. E. Schmid,⁶ and others made similar contributions. W. Dames⁷ has considerably extended our knowledge of *Gyrolepis*, *Colobodius*, and *Serrolepis*, besides adding a previously unknown Lepidosteoid genus, *Crenilepis*; and quite lately W. Deecke⁸ has described an extensive series of fishes from the Muschelkalk of Perledo, on the Lake of Como, already briefly noticed by Bellotti.⁹

In the European Upper Trias, or Keuper, fossil fishes are still more numerous and have been described from various localities in England, Ireland, and Germany, from Seefeld in the Tyrol, and from Raibl in Carinthia. Species of *Dictyopyge*,¹⁰ *Semionotus*,¹¹ and a Dapedioid genus, *Dipteronotus*,¹² are

¹ R. H. Traquair, Quart. Journ. Geol. Soc., 1877, Vol. xxxiii, pp. 562-565.

² W. Deecke, "Fische aus dem Buntsandsteine des Rheinthaales," Palæontographica, 1889, Vol. xxxv, pp. 98-108, Pl. vi, figs. 1, 11.

³ L. Agassiz, Recherches sur les Poissons Fossiles, 1843, Vol. ii, *passim*.

⁴ H. von Meyer, "Fossile Fische aus dem Muschelkalk von Jena, Querfurt und Esperstädt," and "Fische, etc., aus dem Muschelkalk Oberschlesiens," Palæontographica, 1849, Vol. i.

⁵ P. Gervais, Zoologie et Paléontologie Françaises, 1st. edit. 1852.

⁶ E. E. Schmid, "Die Fischzähne der Trias bei Jena," Nova Acta Acad. Cæs. Leop.-Car., 1861, Vol. xxix, No. 9.

⁷ W. Dames, "Die Ganoiden des deutschen Muschelkalks," Pal. Abhandlungen, 1888, Vol. iv, pt. 2.

⁸ W. Deecke, "Fische aus den schwarzen Schiefer von Perledo," Palæontographica, 1889, Vol. xxxv, pp. 110-133, with figs.

⁹ C. Bellotti, "Descrizione di Alcune Nuove Specie di Pesci Fossili di Perledo e di Altre Località Lombarde," in A. Stoppani, "Studii Geol. e Paleont. Lombardia," 1857, pp. 419-438 (without figs.)

¹⁰ *Dictyopyge superstes*, Egerton sp.

¹¹ E. T. Newton, "On the Remains of Fishes from the Keuper of Warwick and Nottingham," Quart. Journ. Geol. Soc., 1887, Vol. xliii, pp. 537-539, Pl. xxii, figs. 1-8.

¹² Sir Phillip Egerton, "On a Fossil Fish from the Upper Beds of the New Red Sandstone at Bromsgrove," Quart. Journ. Geol. Soc., 1854, Vol. x, pp. 367-371, Pl. xi.

known from the English Keuper; and *Dictyopyge catopterus*¹ occurs in beds of corresponding age at Tyrone, Ireland. Four species of *Semionotus*², and one of *Dictyopyge*³, are recognized in the German Keuper, while *Belonorrhynchus* probably occurs⁴; and the deposits both of Raibl and Seefeld are very prolific, as shown by the well-known memoirs of Kner.⁵

In the United States, the Trias of the Connecticut Valley, and of New Jersey and Virginia, also yields fossil fishes of the genera *Dictyopyge*,⁶ *Catopterus*,⁷ *Semionotus* (*Ischypterus*),⁸ *Diplurus*,⁹ and *Ptycholepis*¹⁰; and a single imperfect specimen from Virginia pertains to a deep-bodied fish, perhaps related to *Dapedius*.

In South Africa, the Karoo Formation has furnished a few fossils referable to the genera *Semionotus*,¹¹ *Cleithrolepis*,¹² and undescribed Palæoniscidæ; and the early Mesozoic Koto Group of India yields *Lepidotus*, *Dapedius*, *Tetragonolepis*,¹³ and possibly *Cleithrolepis*,¹⁴ while the Maleri beds of the same country add teeth of *Ceratodus*.¹⁵

The fossil fishes of the Rhætic beds are mostly known only by detached teeth and scales, described by Agassiz (*op. cit.*), Meyer and Plieninger,¹⁶ Quenstedt,¹⁷ and others, from the bone-beds of Gloucestershire and Württemberg. Species of *Pholidophorus*,¹⁸ however, and a closely allied genus, *Legnonotus*,¹⁹ are determined by Egerton from the Rhætic of Aust Cliff, near

¹ See R. H. Traquair, Quart. Journ. Geol. Soc., 1877, Vol. xxxiii, pp. 565-567.

² *Semionotus Bergeri*, Agassiz; *S. Kapffi*, O. Fraas; *S. serratus*, O. Fraas; and *S. elongatus*, O. Fraas.

³ *Dictyopyge socialis*, Berger, sp.

⁴ Portions of mandible in the Stuttgart Museum.

⁵ R. Kner, "Die Fische der bituminösen Schiefer von Raibl in Kärnten," Sitzungsab. math. naturw. Cl. k. Akad. Wiss., 1866, Vol. liii, Pt. i, pp. 152-197, pls. i-vi. "Nachtrag zu den fossilen Fischen von Raibl," *ibid.*, 1867, Vol. lv, Pt. i, pp. 718-722, with plate. "Die fossilen Fische der Asphalttschiefer von Seefeld in Tirol," *ibid.*, 1866, Vol. liv, Pt. i, pp. 303-334, Pls. i-vi. "Nachtrag zur fossilen Fauna der Asphalttschiefer von Seefeld in Tirol," *ibid.*, 1867, Vol. lvi, Pt. i, pp. 898-913, Pls. i-iv.

⁶ *Dictyopyge macrura*, W. C. Redfield sp.

⁷ *Catopterus graciles*, J. H. Redfield, Ann. New York Lyceum Nat. Hist., 1848, Vol. iv, p. 37, Pl. i. *C. anguilliformis* and *C. parvulus*, W. C. Redfield, Amer. Journ. Sci., 1841, Vol. xli p. 27-28. *C. Redfieldi*, Egerton, Quart. Journ. Geol. Soc., 1847, Vol. iii p. 278.

⁸ See Sir Phillip Egerton, Quart. Journ. Geol. Soc., 1847, Vol. iii p. 277; and *ibid.*, 1850, Vol. vi p. 8.

⁹ *Diplurus longicaudatus*, J. S. Newberry, Ann. New York Acad. Sci., 1879, Vol. i, p. 127.

¹⁰ *Ptycholepis Marshi*, J. S. Newberry, *ibid.*, p. 127.

¹¹ *Semionotus capensis*, A. S. Woodward.

¹² *Cleithrolepis Extoni*, A. S. Woodward.

¹³ Sir Philip Egerton, "On some Remains of Ganoid Fishes from the Deccan," Pal. Indica, 1878, Ser. 4, No. 2.

¹⁴ *Tetragonolepis analis*, Egerton, *ibid.*, p. 5, Pl. iii, fig. 1.

¹⁵ L. C. Miall, "On the Genus *Ceratodus*, with special reference to the Fossil Teeth found at Malédi," Pal. Indica, 1878, Ser. 4, No. 2.

¹⁶ H. von Meyer and T. Plieninger, "Beiträge zur Paläontologie Württembergs," 1844.

¹⁷ F. A. Quenstedt, "Der Jura," 1856.

¹⁸ *Pholidophorus Higginsi* and *P. nitidus*, Egerton, Mem. Geol. Surv., Gt. Brit., 1855, Dec. viii No. 7, pp. 1-3, Pl. vii, figs. 1-8.

¹⁹ Egerton, *ibid.*, No. 7, pp. 4, 5, Pl. vii, figs 9-12

Bristol; another *Pholidophorus* is known from Germany¹; and a skull of *Ceratodus* was discovered in 1886 in the Rhætic of Austria.²

The most prolific of the fish-bearing horizons of the Lias is the well-known lower division of Lyme Regis, Dorsetshire, with its equivalents in other parts of England. Here, indeed, nearly all the principal Liassic genera are so well represented that reference need not be made to any corresponding fauna elsewhere. In addition to several Selachians and Chimæroids, and one Sturgeon (*Chondrosteus*), there are four genera and species of Palæoniscidæ,³ at least one genus of Cœlacanthidæ,⁴ and a single species of the remarkable *Belonorhynchus*.⁵ *Semionotus* is absent,⁶ but *Dapedius*⁷ (including *Amblyurus*⁸), *Lepidotus*,⁹ *Pholidophorus*,¹⁰ *Eugnathus*,¹¹ including *Conodus*,¹² *Heterolepidotus*,¹³ and *Lissolepis*,¹⁴ and *Ptycholepis*¹⁵ represent the early Lepidosteoids; a species of *Mesodon*¹⁶ belongs to the Pycnodontidæ; *Pachycormus*¹⁷ points towards a higher type of fish organization; and *Leptolepis*¹⁸ is the forerunner of fishes with completed vertebral centra. There are also other genera of more doubtful position, including *Platysiagum*,¹⁹ *Endactis*,²⁰ *Isocolum*,²¹ *Osteorhachis*,²² and *Harpactira*.²³

In comparing these various faunas with that of the Hawkesbury beds, it is obviously only necessary to make a selection of the leading types pertaining to the more specialized groups. Cœlacanths being absent at Gosford, they may be dismissed from consideration; and the Palæoniscidæ

¹ *Pholidophorus Roemeri*, K. Martin, Zeitschr. deutsch. Geol. Ges., 1874, Vol. xxvi pp. 816-819, Pl. xxix, figs. 1, 2.

² D. Stur, Verh. k. k. Geol. Reichsanst. Wien, 1886, pp. 381-383.

³ *Centrolepis asper*, Egerton, Mem. Geol. Surv. 1858, Dec. ix No. 5. *Cosmolepis Egertoni*, Egerton, *ibid.*, Dec. ix, No. 1. *Orygnathus ornatus*, Egerton, *ibid.*, 1855, Dec. viii No. 9. *Thrissonotus Colei*, Egerton, *ibid.*, Dec. ix, No. 2.

⁴ *Holophagus*, Egerton, *ibid.*, 1866, Dec. xii p. 26, Pl. vi; and *ibid.*, 1872, Dec. xiii No. 10.

⁵ *Belonostomus acutus*, L. Agassiz, "Rech. Poiss. Foss.," 1843, Vol. ii, Pt. ii p. 142, Pl. xlvii a, figs. 3, 4. Probably identical with *Belonostomus Auningii*, L. Agassiz, *tom. cit.*, Pt. ii, p. 143 (name only), assigned to *Belonorhynchus* by Smith Woodward, Ann. and Mag. Nat. Hist. [6] Vol. i, p. 354.

⁶ The so-called *Semionotus rhombifer*, Agassiz, is *Heterolepidotus*, Egerton (Smith Woodward, Ann. and Mag. Nat. Hist. [5] Vol. xx, p. 178).

⁷ L. Agassiz, *tom. cit.*, Pt. i, p. 181.

⁸ L. Agassiz, *tom. cit.*, Pt. i, p. 220.

⁹ L. Agassiz, *tom. cit.*, Pt. i, p. 233.

¹⁰ L. Agassiz, *tom. cit.*, Pt. i, p. 271.

¹¹ L. Agassiz, *tom. cit.*, Pt. ii, p. 97.

¹² L. Agassiz, *tom. cit.*, Pt. ii, p. 105 (name only).

¹³ Egerton, Mem. Geol. Surv., 1872, Dec. xiii, Nos. 2, 3.

¹⁴ J. W. Davis, Ann. and Mag. Nat. Hist. 1884, [5] Vol. xiii pp. 449-453, Pl. xvi.

¹⁵ L. Agassiz, *tom. cit.*, Pt. ii, p. 107.

¹⁶ *Pycnodon liassicus*, Egerton, *loc. cit.* 1855, Dec. viii, No. 10. Assigned to *Mesodon* by J. J. Heckel, Denkschr. math.-naturw. Cl. k. Akad. Wiss. Wien, 1856, Vol. xi p. 202.

¹⁷ L. Agassiz, *tom. cit.*, Pt. ii, p. 110.

¹⁸ L. Agassiz, *tom. cit.*, Pt. ii, p. 129.

¹⁹ Egerton, *loc. cit.*, 1872, Dec. xiii No. 6.

²⁰ Egerton, *ibid.*, 1858, Dec. ix, No. 4.

²¹ Egerton, *ibid.*, 1872, Dec. xiii No. 4.

²² Egerton, *ibid.*, 1872, Dec. xiii No. 5.

²³ *Harpactes*, Egerton, Geol. Mag. 1876, [2] Vol. iii p. 441. *Harpactira*, Egerton, *ibid.*, p. 576.

are not of much importance, though, as already pointed out, the Hawkesbury *Myriolepis* is most nearly related to the lower Liassic *Thrissonotus*. Dipnoans and Selachians, too, do not call for remark; and the known distribution of the really significant genera may be concisely arranged in tabular form, thus:—

TABLE SHOWING THE GEOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF THE VARIOUS GENERA.

	Bunter.	Muschelkalk.	Keuper.					Rhætic.	L. Lias.	"Trias."	Koto beds.	Karoo beds.	Hawkes- bury beds.
	Germany.	Germany.	Perledo.	England.	Germany.	Seefeld.	Raibl.	England and Germany.	England.	U.S.A.	India.	S. Africa.	N.S.W.
CATOPTERIDÆ.													
Catopterus	x	.....	.....	.....
Dictyopyge	x	.....	.....	x	x	.....	.....	.....	.....	x	.....	.....	x
BELONORHYNCHIDÆ.													
Belonorhynchus	x	.....	x	x	x	.....	x	.....	.....	.....	x
Saurichthys	x	.....	.....	.....	.....	.....	x	.....	.....	.....	.....	?
SEMIONOTIDÆ.													
Semionotus	x	.....	x	x	x	x	.....	x	.....	x	.....	x	x
Pristisomus	x
Dapedius	x	?	x	.....	.....
Cleithrolepis	?	x	x
Tetragonolepis	x	.....	x	.....	.....
LEPIDOTIDÆ.													
Lepidotus	x	.....	.....	x	.....	x	.....	.....
PHOLIDOPHORIDÆ.													
Pholidophorus	x	.....	.....	x	x	x	x	.....	.....	.....	x
Ophiopsis	x	.....	.....	.....	.....	.....	x	.....	.....	.....	.....
Ptycholepis	x	.....	x	x	.....	.....	.....
PACHYCORMIDÆ.													
Pachycormus	x	.....	.....	x	.....	.....	.....	.....
LEPTOLEPIDÆ.													
Leptolepis	x	.....	.....	.....	.....
Megalopterus	x	.....	.....	.....	.....	.....	.....
PYCNODONTIDÆ.													
Mesodon	x	.....	.....	.....	.....

Of the six Hawkesbury genera comprised in this list, it will thus be observed that four are represented in the European Trias, two of these (*Dictyopyge* and *Semionotus*) being typically Triassic, another (*Belonorhynchus*) commonly ranging to the Lias, and the fourth (*Pholidophorus*) being best developed in this and later Jurassic deposits. The fifth genus (*Pristisomus*) is new, but scarcely higher in rank than *Semionotus*; and *Cleithrolepis* has only been definitely recognized elsewhere in the Stormberg

beds of South Africa, which may be either late Triassic, Rhætic, or Lower Jurassic.

Perhaps the most important fact, however, is the absence in the Hawkesbury beds of fishes with well-developed vertebral centra. Only one fragment of a fish of this type (*Megalopterus*) has hitherto been discovered in the European Keuper, and nothing is known of any allies in the Rhætic; but in the Lower Lias, *Leptolepis* is one of the most abundant and characteristic fossils, and well distinguishes the horizon from those beneath. Moreover, *Pachycormus* occurs in the Lower Lias, and seems to have only a single Triassic representative at Seefeld*; and in the British Museum there are now examples of the Pycnodont *Mesodon* from three Lower Liassic localities.

In the Fish-fauna of the Lower Lias, there are thus several elements that become especially characteristic in later Jurassic times, and of which there are no traces in the Hawkesbury collection; though they have two solitary representatives in the uppermost European Keuper. So far as can be determined from the fishes, therefore, the Hawkesbury beds may be regarded as homotaxial with the Keuper of Europe, or, at latest, with the Rhætic; and, on the whole, the present writer is inclined to adopt the first of these interpretations.

* *Eugnathus insignis*, R. Kner, Sitzungsab. math.-naturw. Cl. k. Akad. Wiss. Wien, 1866, Vol. liv, Pt. i, pp. 306-313, Pl. I.

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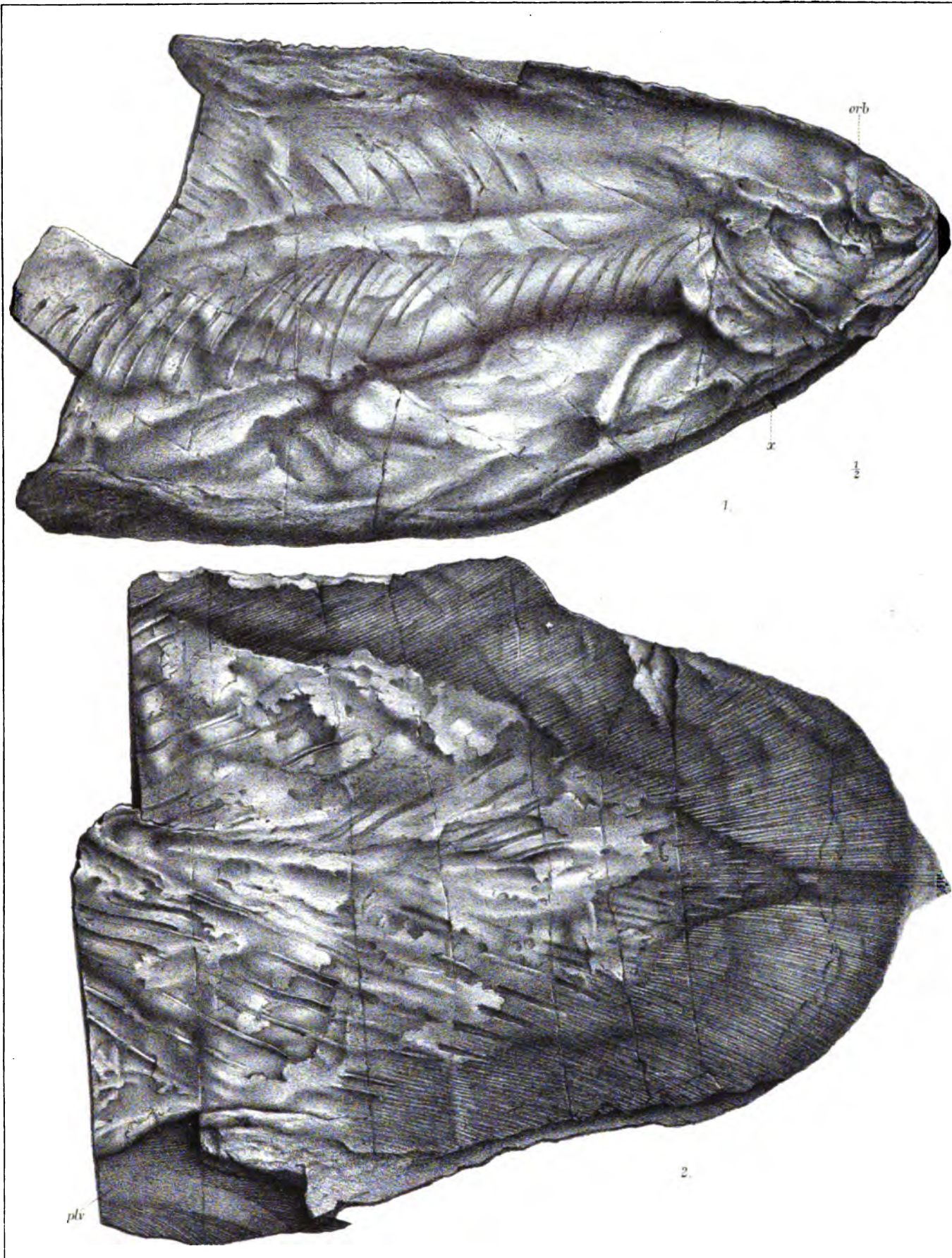
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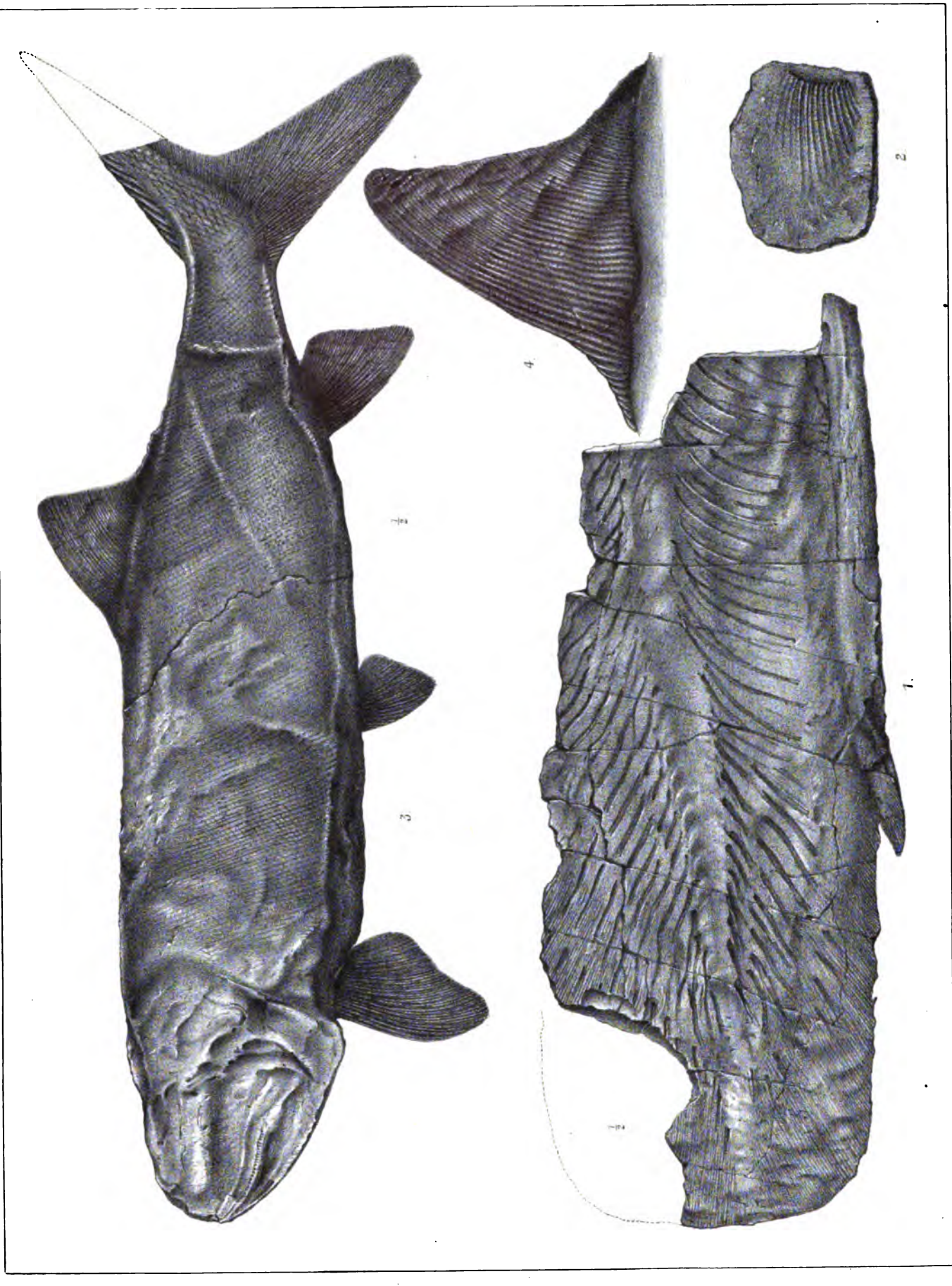
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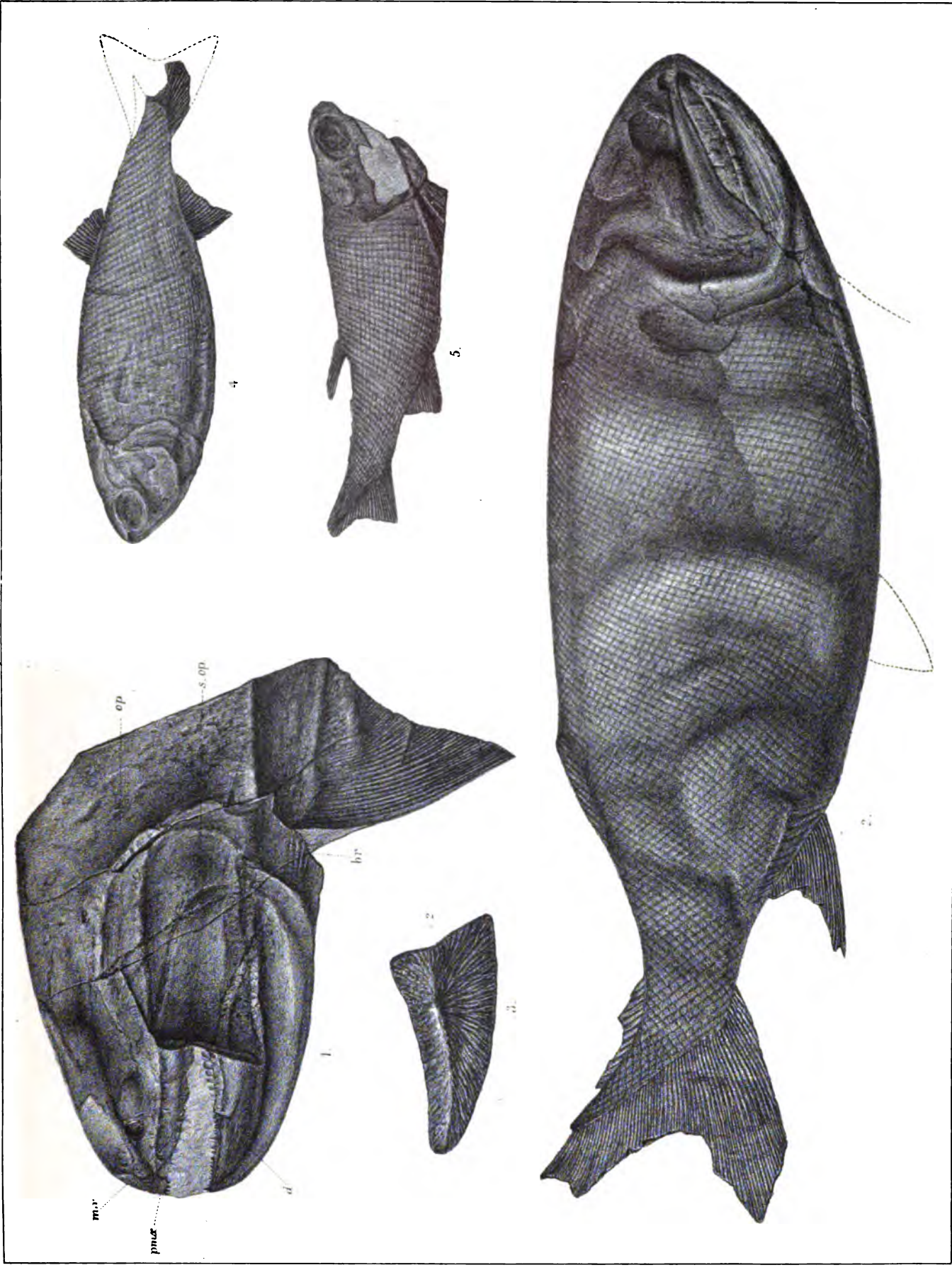


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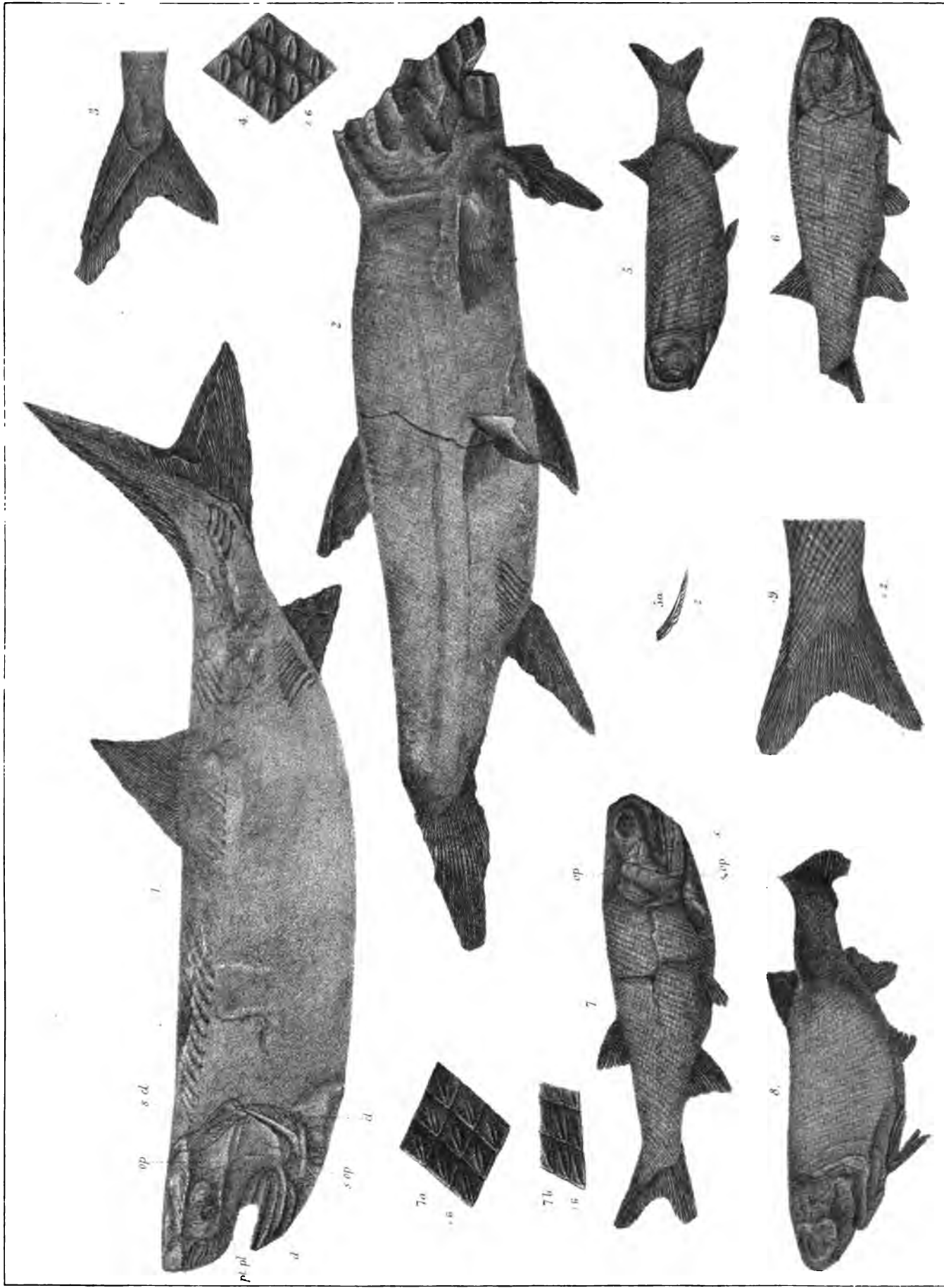
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1-3. MYRIOLEPIS. 4, 5. DICTYOPYGE.

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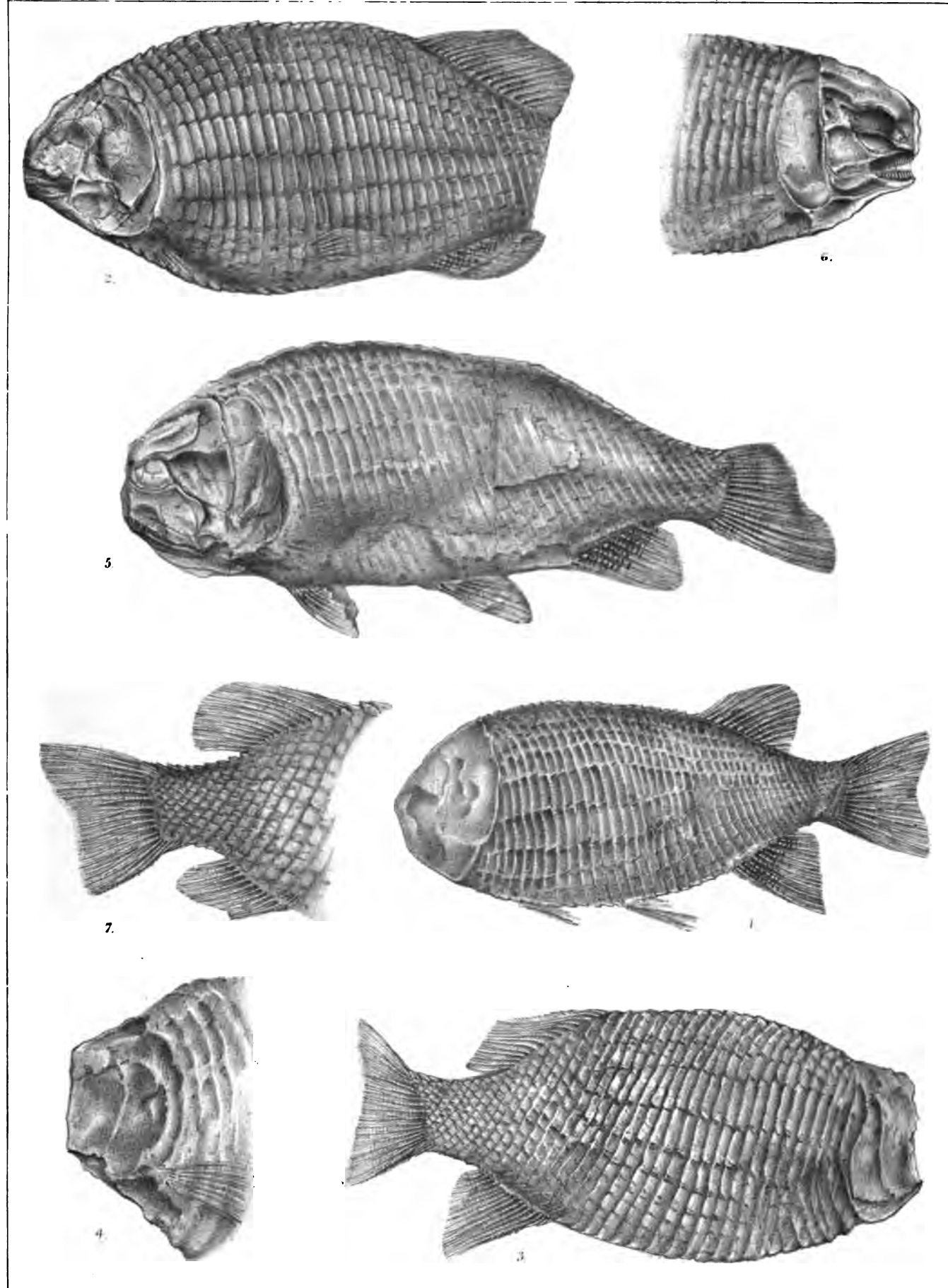
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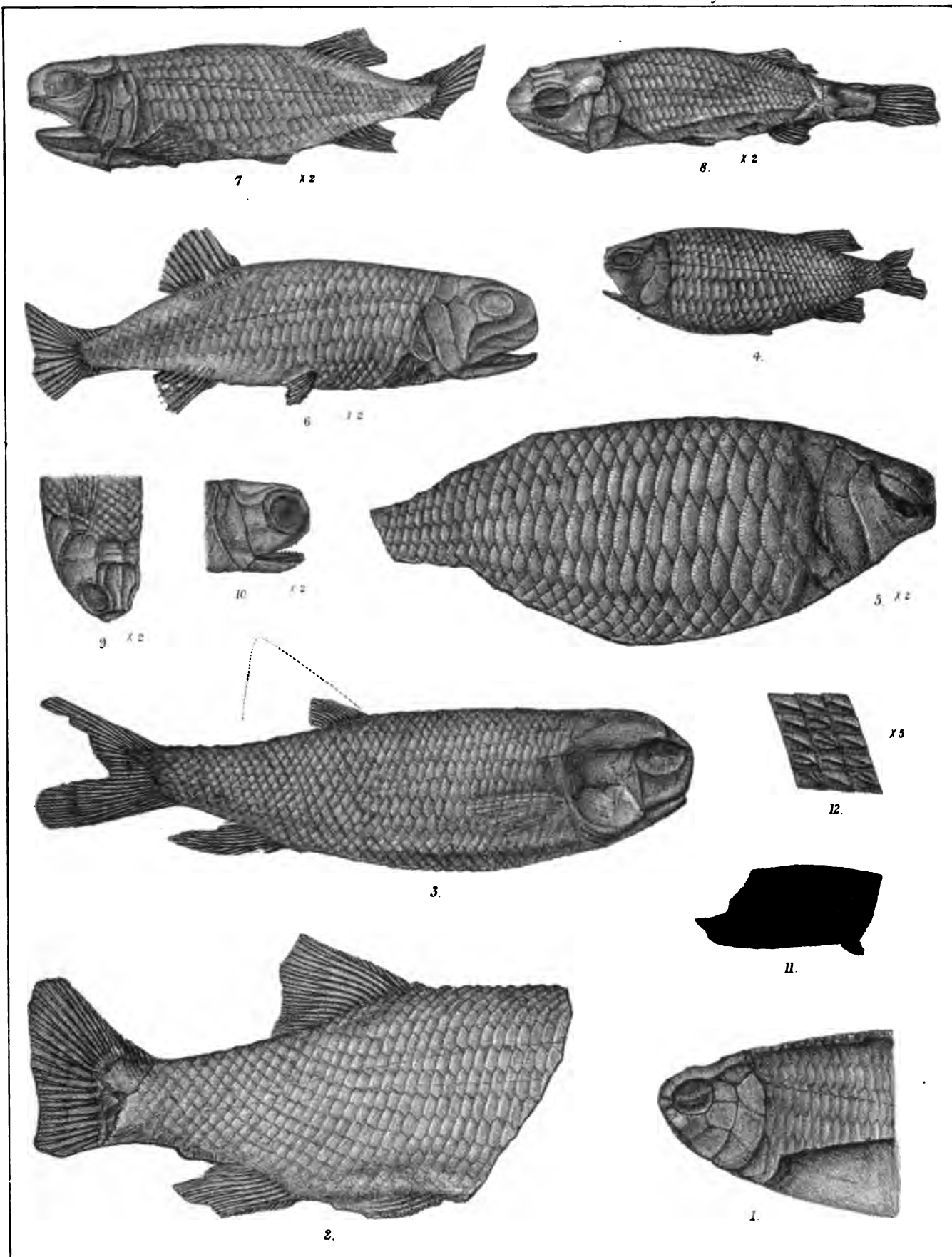
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PRISTISOMUS

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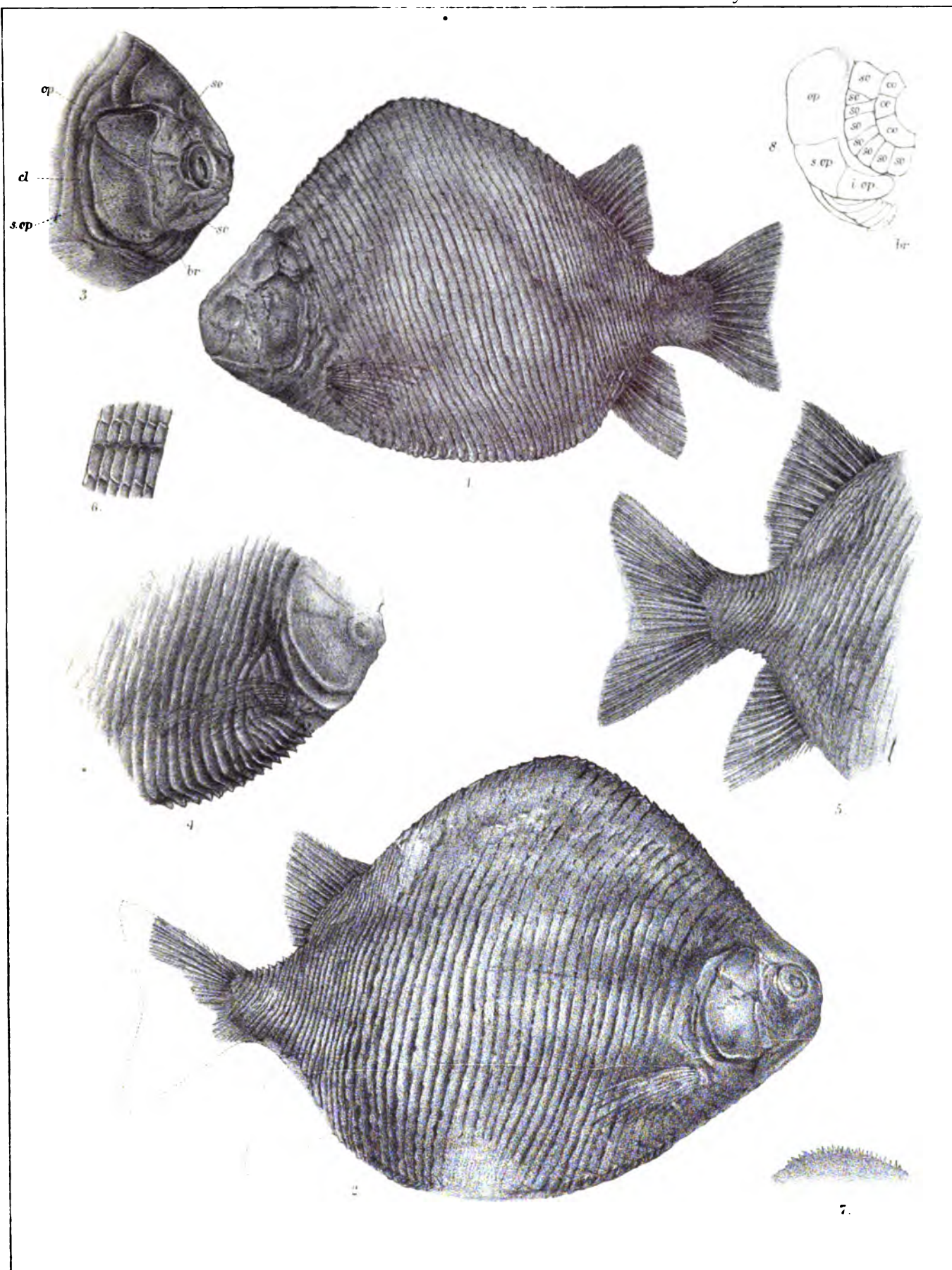
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1. PRISTISOMUS. 2, 3. SEMIONOTUS. 4, 5. PELTOPLEURUS (?). 6-10. PHOLIDOPHORUS.

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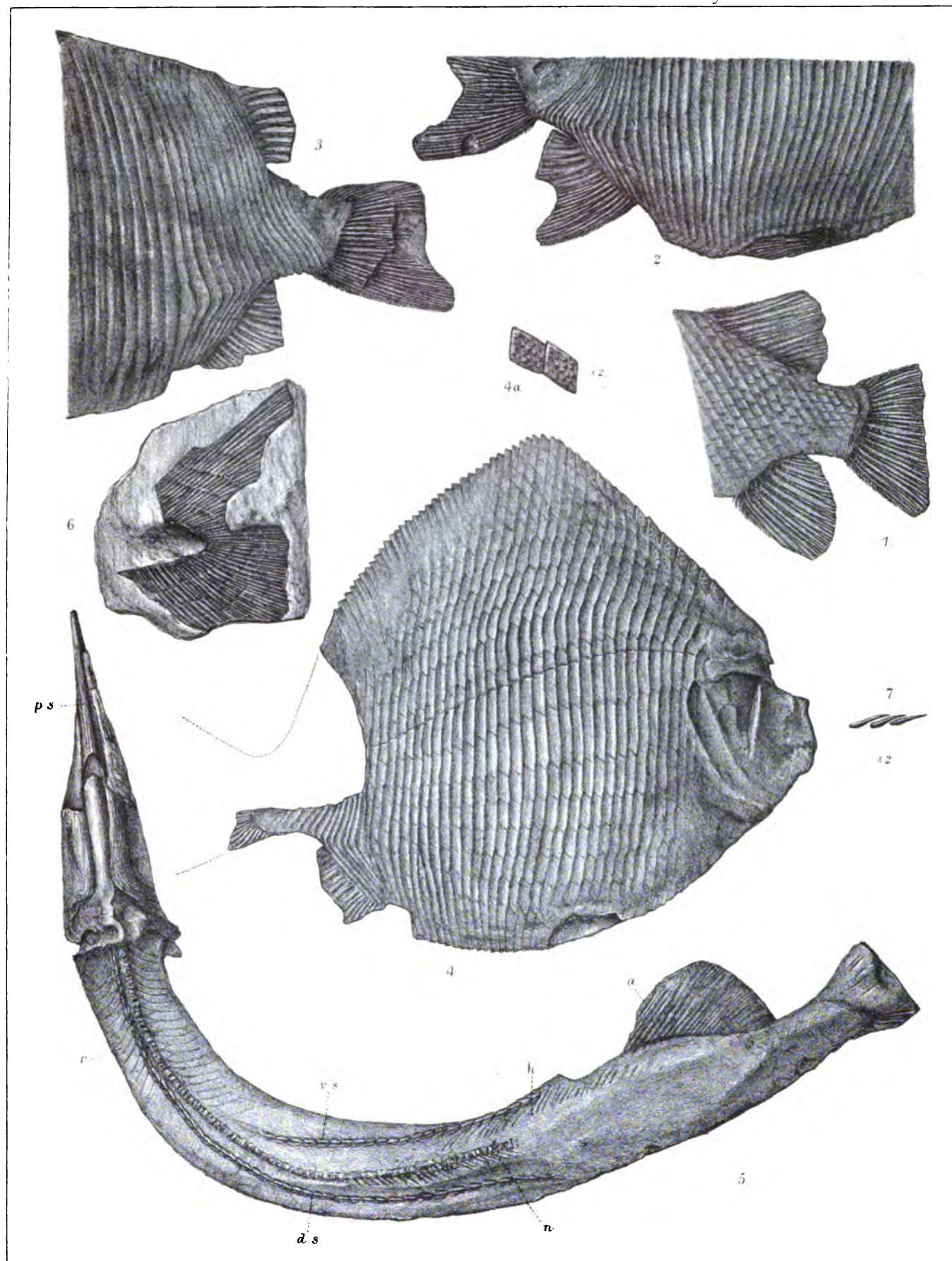
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CLEITHROLEPIS.



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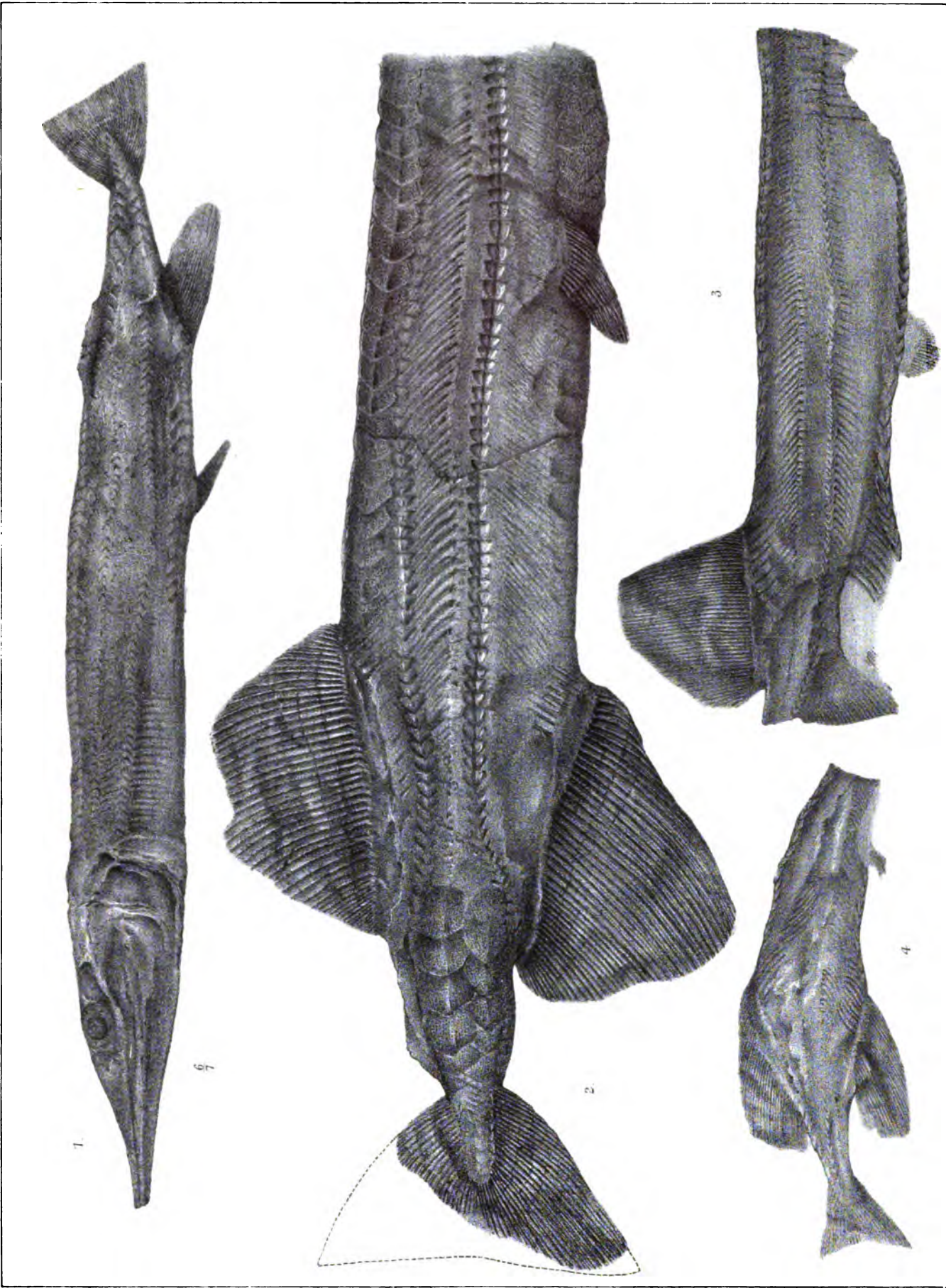
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1. PRISTISOMUS. 2-4. CLEITHROLEPIS.
5-7. BELONORHYNCHUS.

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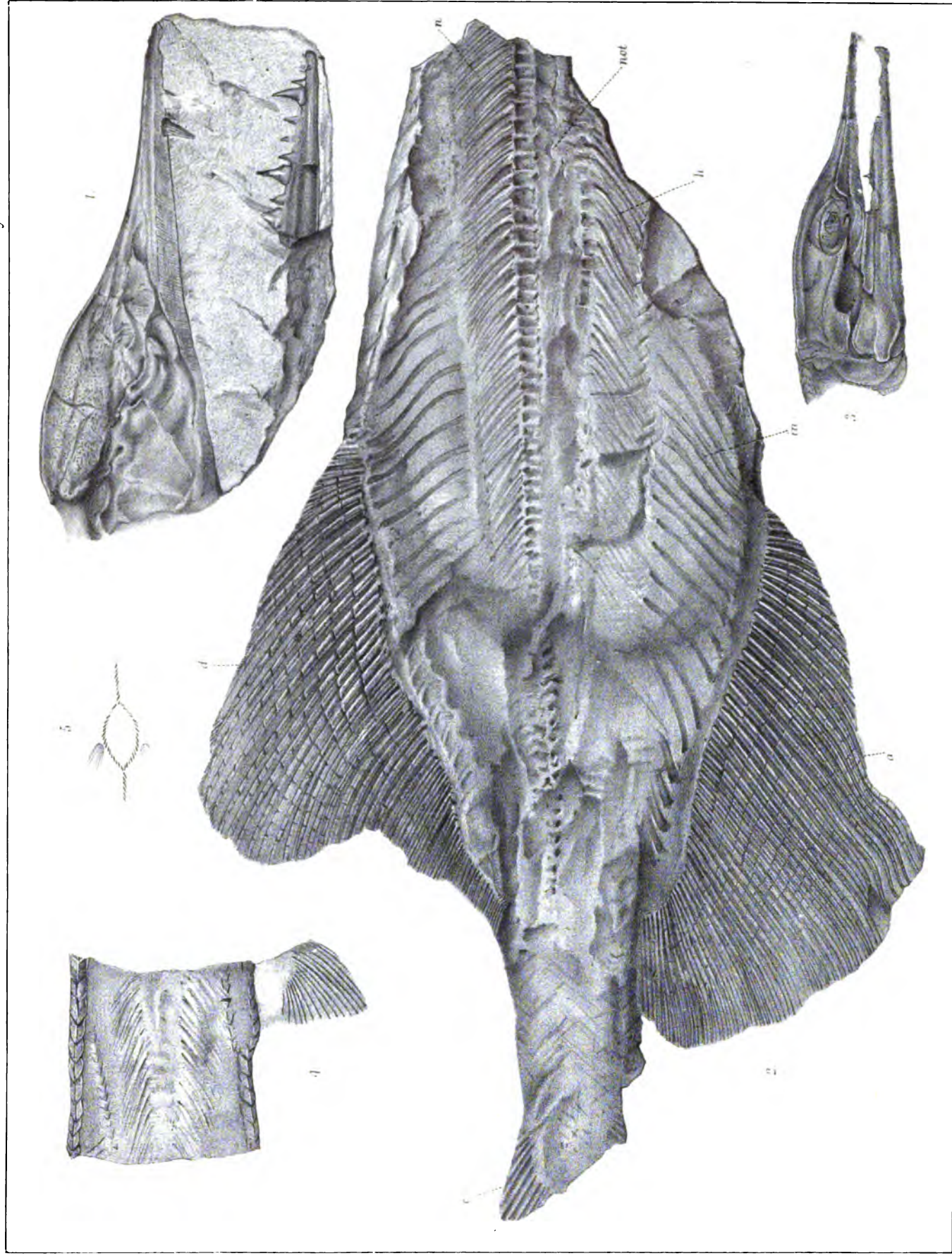
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BELONORHYNCHUS.



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BELONORHYNCHUS.

Wentworth, Proc. Imp.

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